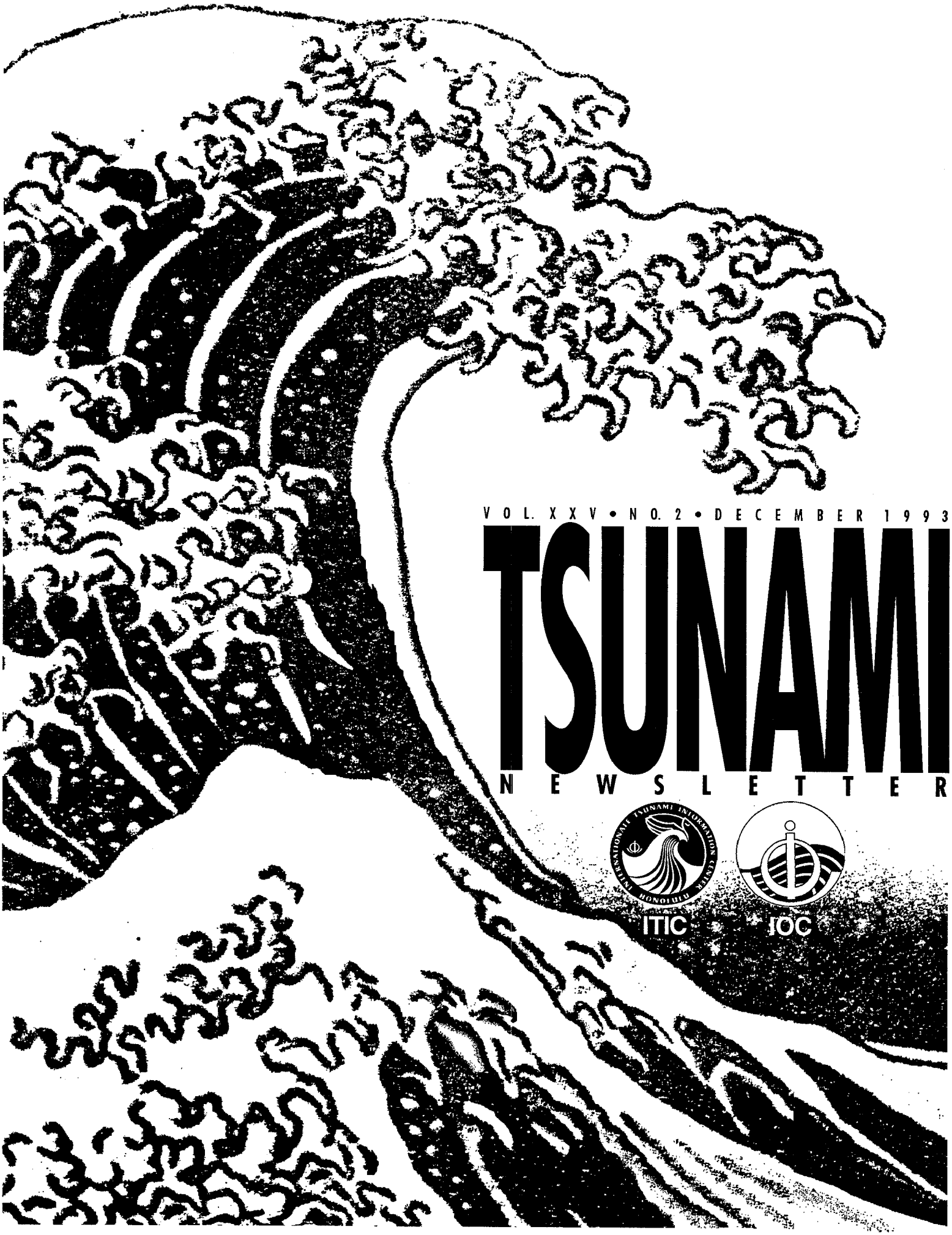

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TSUNAMI NEWSLETTER

ITIC IOC

TSUNAMI NEWSLETTER - DECEMBER 1993

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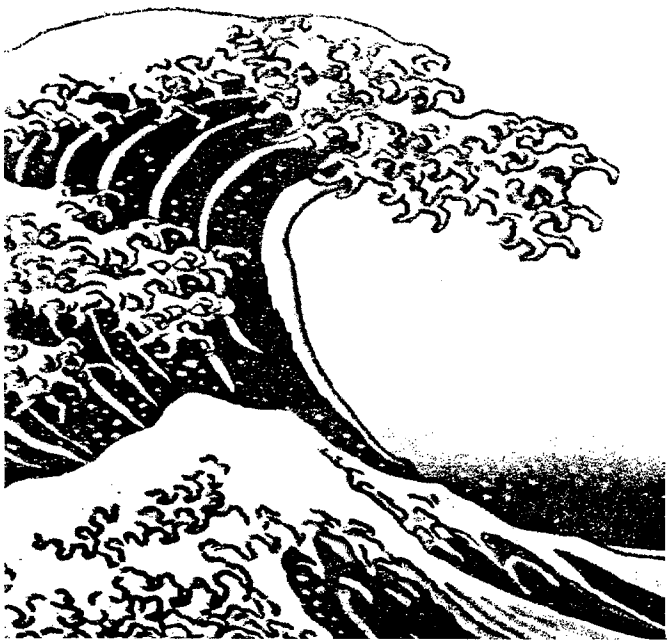
TSUNAMI NEWSLETTER is published semi-annually by the International Tsunami Information Center (ITIC) to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

The ITIC is maintained by the U.S. National Oceanic & Atmospheric Administration (NOAA) for the Intergovernmental Oceanographic Commission (IOC). The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.



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WESTERN SAMOA

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NEWS EVENTS

EARTHQUAKE AND TSUNAMI REPORT, JULY THROUGH NOVEMBER 1993

A number of large earthquakes and one regionally devastating tsunami occurred during this reporting period. The following brief reports summarize the significant events; see related articles for more information.

A major earthquake (M_S=7.8) struck northern Japan at 22:17 local time (13:17 GMT) on July 12, 1993. The epicenter was located under the Sea of Japan about 50 km northwest of Hokkaido Island at about 30 km depth.

Five minutes after the shock, up to intensity V on the Japan Meteorological Agency (JMA) scale, JMA issued a tsunami warning. Tsunami waves generated by this major earthquake hit surrounding coasts; the highest waves rose >30m at Okushiri Island, southwest of Hokkaido, which has a population of about 4,700.

As of July 21, 1993, 185 people had been killed by the earthquake and tsunami waves, 68 were still missing, and about 240 were injured. Most of the deaths occurred at Okushiri Island. A total of about 700 houses were destroyed or burnt, another 2,000 houses were damaged, and about 800 boats were damaged. Damage to boats was reported as far as 800 km southwest of the source area. There were 89 aftershocks felt by the morning of July 16, centered in an area 50 km east-west by 120 km north-south.

The main shock was located in the north part of the aftershock area; Okushiri Island is just southeast of the aftershock area. The largest aftershock was an M_S=6.3 on July 13. Portions of Okushiri Island subsided nearly one meter, creating dramatic changes to the coastline. (See related article)

On October 13, 16, and 25, 1993, a series of strong earthquakes struck the area of northern Papua New Guinea; there are reports that as many as 160 people were killed. Further strong aftershocks hit the area in the following weeks. There was no report of tsunami activity associated with these earthquakes, most likely because the earthquakes were located inland. (See related article)

Large Earthquake Near Kamchatka, Russia

(The following report was received from V. Gusiakov at the Novosibirsk Computing Center)

According to information provided by the Kamchatka Tsunami Center in Petropavlovsk-Kamchatsky, a tsunami warning was issued on November 13, 1993, at 17:29 (local time) for the whole east coast of Kamchatka after an earthquake with operational magnitude 6.9 occurred at 17:18 (local time), 100 miles SE of Petropavlovsk-Kamchatsky, where it was felt with intensity of 5 to 6 on the 12-grade scale; some minor damage was reported.

The tsunami warning was canceled at 18:44 (local time). No damage from tsunami was reported; a 10 cm amplitude wave was recorded on the Petropavlovsk-Kamchatsky tide gauge which is located inside Avacha Bay. (The US Geological Survey, National Earthquake Information Center, located the earthquake at 52.0 degrees north latitude by 158.8 degrees east longitude with a surface magnitude of 7.1. Origin time was 01:18 GMT, November 13, 1993.)

Papua New Guinea Earthquakes, October 1993

A series of large earthquakes and numerous aftershocks have hit Papua New Guinea beginning on October 13, 1993. The M_S=7.2 and 6.8 earthquakes of October 13 hit about 28 kilometers from Madang on the country's north coast at 02:06 GMT and 03:47 GMT, respectively. Fifty-eight people were reported killed by these shallow (depth) earthquakes.

The earthquake of October 16, M_S=6.4, set off further landslides in the steep, narrow valleys of the Finisterre mountain range. On October 25, an M_S=7.1 earthquake occurred about 40 kilometers south of Madang. The Australian Air Force provided disaster relief to the impacted areas with temporary shelters for the hundreds of people made homeless by the earthquakes. The Port Moresby Geophysical Observatory (Dr. Horst Letz) provided local data from their regional seismic network on the major earthquakes as well as the numerous, strong aftershocks that rocked the area. Due to the location of the earthquakes, inland from the coast, no tsunami wave activity was reported.

Strong Earthquake Jolts Guam; Small Tsunami Recorded

On Sunday evening August 8, 1993, (18:35 local time) a major earthquake (M_S=8.1) occurred about 50 miles northeast of Agana, Guam. This is the strongest earthquake to hit Guam in the last 84 years and one of the largest earthquakes to occur worldwide in the last two years. The earthquake generated a small tsunami that was recorded at a number of tide gauge stations, including:

	Height (cm)
Guam, Agana Harbor	15+ (see account below)
Kwajalein Atoll	15
In the Hawaiian Islands:	
Nawiliwili, Kauai	6
Port Allen, Kauai	15
Haleiwa, Oahu	10

A personal account by a man fishing at Pago Bay (Guam) reported a tsunami followed the earthquake by a matter of minutes. A rapidly rising tide caught his pickup truck parked on the beach and pulled it out to sea. When he returned to retrieve his truck it was stuck in the sand about 50 feet from shore in waist high water.

Considering the magnitude of the earthquake, damage on Guam was moderate. Earthquake related loses were reported at over $100 million, mainly impacting commercial and residential structures, but with minimal damage to bridges and roadways.

Hokkaido Nansei Tsunami
12 July 1993

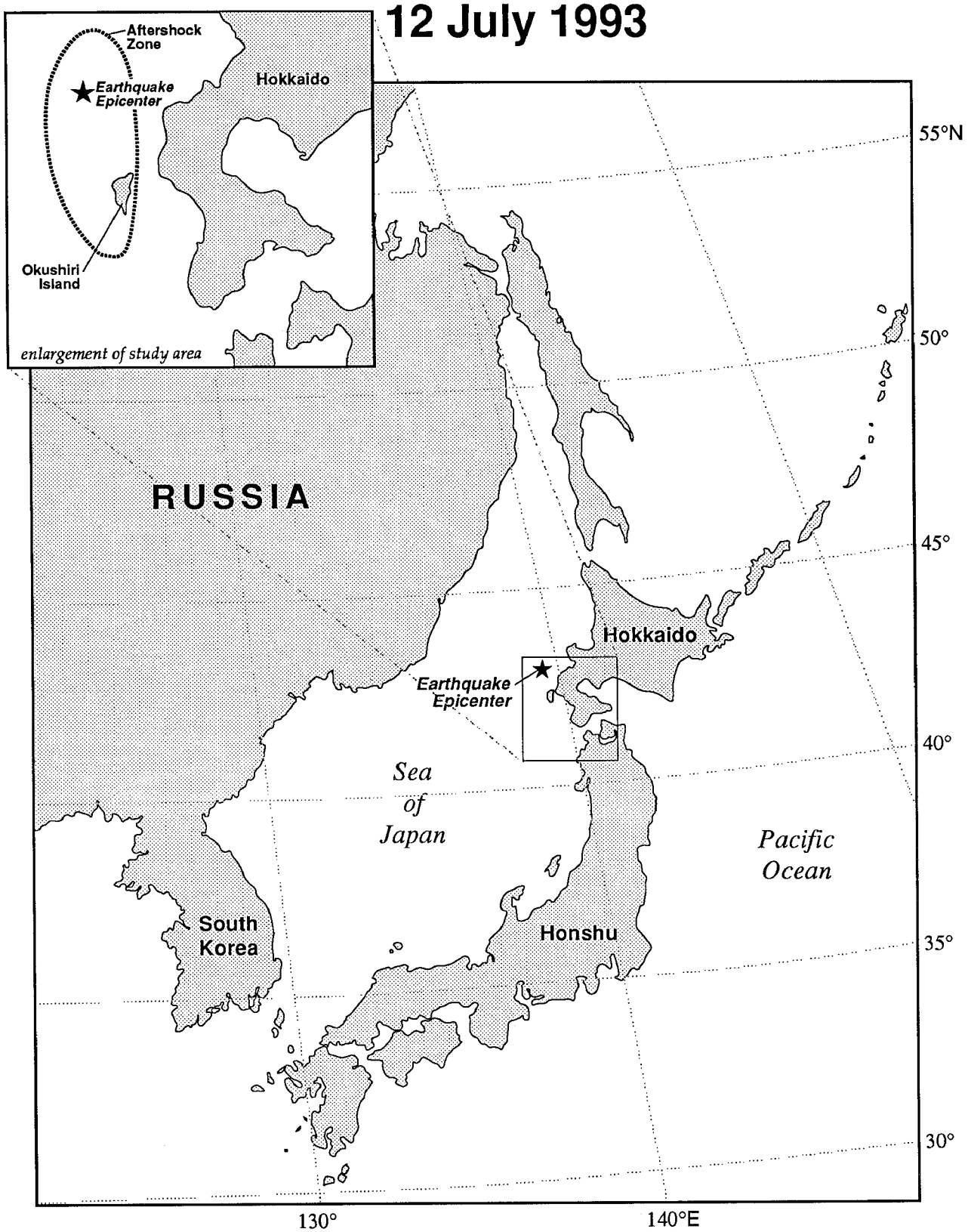


Figure 1. Overview of Area

graphics: NOAA/PMEL

Miraculously, no lives were lost nor were there any serious injuries. The strict building' codes in Guam that help protect structures against the damaging winds associated with tropical cyclones (typhoons) appeared also to help structures withstand the destructive forces of this major earthquake. Mr. Richard Hagemeyer, ICG/ITSU Chairman, was on Guam when the earthquake occurred. He was preparing to leave his hotel room when the earthquake began as a strong, random shaking motion that lasted for nearly a minute. (ed. We are happy to report Mr. Hagemeyer was not injured.)

The Hokkaido Nansei-Oki (Sea of Japan) Earthquake and Tsunami of July 12,1993

The devastating July 12, 1993, Hokkaido Nansei-Oki earthquake and resulting tsunami caused considerable loss of life and property damage in Japan and impacted the countries of Russia, the Republic of Korea and the Democratic People's Republic of Korea causing varying degrees of damage on their coasts as well. Field surveys, aerial photographs, reconnaissance reports and special studies have produced a wealth of significant data and issues that have stimulated intense discussion on this event.

Numerous independent as well as cooperative field investigations immediately followed this incredibly destructive tsunami on Okushiri and Hokkaido Islands (Japan). With rapid coordination provided under the auspices of the United States - Japan Panel on Natural Resources (a cooperative international program), the Acting Director, InC, participated on the cooperative tsunami field survey team studying the tsunami's impact on Okushiri and Hokkaido Islands.

Together with data collected by other researchers in Japan, it was evident very soon in the survey that this tsunami caused localized damage of spectacular proportions. In some locations the local population had little or no time to flee the tsunami and because of the surrounding topography NO PLACE to evacuate. Reports from countries bordering the western Sea of Japan indicate property damage from the tsunami, but with runups nearly an order of magnitude smaller. Our heart-felt sympathy is extended to individuals in all countries impacted by this tsunami. The following abbreviated tabulation of reports, publications and articles provide some idea of the post-event activities that have occurred to date.

A *view of tsunami damage at Aonae, Okushiri Island*

Hokkaido Nansei Tsunami
12 July 1993

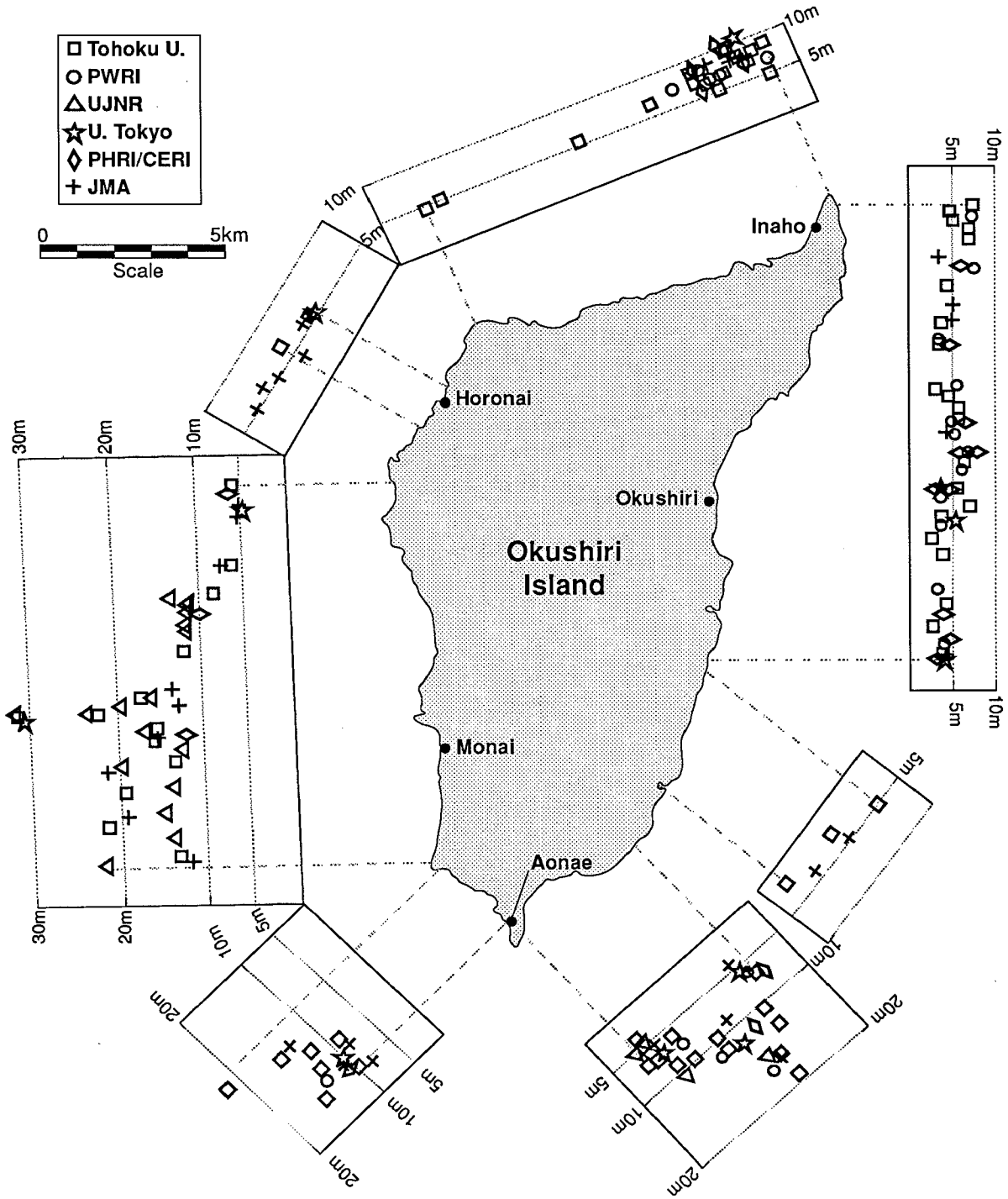


Figure 2. Survey Results, Okushiri Island graphics: NOAA/PMEL

TSUNAMI RUNUP DISTRIBUTION GENERATED BY THE JULY 12,1993, HOKKAIDO NANSEI-OKI EARTHQUAKE

This article was written by Eddie N. Bernard and Frank I. Gonzalez, part of the United States-Japan Cooperative Program in Natural Resources (UJNR) Team.

Introduction and Background

On July 12, 1993, at 2217 local time (1317 GMT), an Ms=7.8 earthquake rocked the west coast of Hokkaido and the small, offshore island of Okushiri in the Sea of Japan (Figure 1). A major tsunami was generated and, within two to five minutes, extremely large waves engulfed the Okushiri coastline and the central west coast of Hokkaido. As of July 21, 185 fatalities were confirmed, with 120 attributed to the tsunami; this death toll is expected to rise, as missing persons are included among the fatalities (Hokkaido Police Headquarters). Property losses have been estimated at $600 million, due principally to tsunami damage.

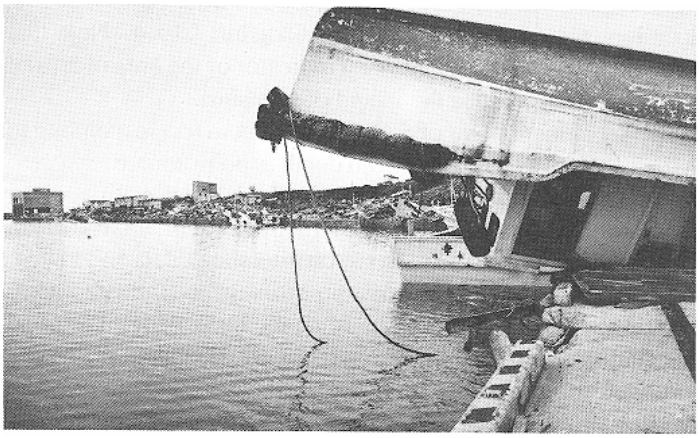
The Japanese immediately dispatched damage assessment and survey teams. Most of these Japanese teams were mobilizedand began surveying tsunamirunup by July 13; on July 18, three U.S. scientists, under the auspices of the UJNR, joined Japanese scientists to complement the tsunami survey.

Field Measurements

The primary measurements in the field surveys were the tsunami vertical and/or horizontal runup values, which are the maximum vertical height and/or horizontal extent of flooding. In this report, only vertical runup estimates are presented. Traces left by the tsunami include water marks on buildings, debris lines along the coast, or vegetation that is damaged or killed by salt water. Measurements of vertical height above sea level of the tsunami trace are obtained by a series of measurements down to the shoreline, using a surveyor's staff and level. The effects of tides are normally removed from such measurements, but during the period of the survey, the predicted tidal range in the study area was only 2-30 cm, referred to mean

Figure 2. *Distribution of vertical tsunami runup for Okushiri Island. The legend indicates data source, and runup values are projected onto offshore scales. A projection from a data point onto the coastline will identify the geographical position of the measurement.*

Spectacular 30 meter runup north of Monai, Okushiri Island. (Survey team members, l. to r., K. Kato, E. Bernard, F. Gonzalez)



Tsunami damage to the harbor at Aonae

Damaged car surrounded by debris deposited by tsunami at Aonae

sea level. Since this range is a relatively small fraction of the observed runup, the data presented in this report are not corrected for tides. This report is a collaborative effort that pools 245 measurements acquired by six of the survey teams; 152 around the island of Okushiri and 93 along the western coast of Hokkaido. These measurements included 110 by Tohoku University, 48 by the Public Works Research Institute (PWRI), 44 through the combined efforts of the Port and Harbor Research Institute (PHRI) and the Civil Engineering Research Institute (CERI), 28 by UJNR, and 15 by the University of Tokyo. Survey data collected by the JMA is also presented. Some sites were visited by more than one team as shown in Figures 2 and 3, which summarize the data.

Another very important source of information is the approximate time of tsunami arrival, as inferred by the time at which clocks have stopped due to saltwater flooding. The UJNR team conducted an active search for such clocks in the tsunami debris and in the surrounding area of each of the 28 sites visited. Eight clocks were found in various locations - on the beach, in wrecked automobiles, and in homes and other buildings - which are taken to be a rough indication of tsunami arrival times.

Description of the Earthquake/Tsunami

Figure 1 provides an overview of the region, including the aftershock zone (courtesy JMA) for a 40-hour period, and its location relative to Hokkaido and Okushiri Island. Note that this zone, frequently taken as an indicator of the area of crustal deformation, includes the island of Okushiri.

The seismic moment of 5.6×10^{27} dyne/cm (corresponding to M_w=7.8) with a (fixed) centroid depth (a point source representative of the overall faulting) of 15 km was estimated by Harvard University. Assuming a fault length of about 150 km and a fault width of 50 km based on aftershock data and a shear modulus of 3 x 1011 dyne/cm^2, this moment and fault geometry suggests an average slip of 2.5 m on the fault plane. The focal mechanism estimated by Harvard has one nodal plane dipping eastward at 24 degrees from the horizontal. This fault plane orientation is comparable with the aftershock distribution and is consistent with subduction of the floor of the Japan Sea beneath northern Japan.

The tsunami was probably generated within the deformation area as defined by the aftershock pattern shown in Figure 1. Eye-witness accounts collected by Y. Tsuji (University of Tokyo) and F. Imamura (Tohoku University) indicate that the tsunami hit the west coast of Okushiri Island almost immediately after the main shock. The UJNR tsunami survey team found the electric clock at an electrical power station had stopped at 22:23, which was 6 minutes after the start of the earthquake. Along the west coast, the tsunami runup measurements were the highest from north of Monai (see Figure 2). The village of Monai was totally destroyed (10 persons killed and all 12 houses destroyed). Runup measurements around the village were 20 m (See photo 4), and in a small valley north of Monai, the runup was measured at 31 m. South of Monai, tsunami runups between 15 and 20 m were measured all along the coast. Vegetation was stripped off the hillside, and large boulders (up to 1 m in diameter) were deposited where the vegetation was flooded. These data are consistent with the initial wave arriving from the west of Okushiri Island very near the generation area.

The tsunami was refracted by the shoaling bathymetry at both ends of the island. Hardest hit was the town of Aonae (population 1,600), where the first tsunami wave flooded the southern tip of the Island and the entire first row of houses in the harbor area within 4-5 minutes after the main shock (see cover photos). Tsuji reported (based on eye-witness interviews) that the tsunami arrived from the northeast, with flooding of 3-7 m throughout the town. Two fires broke out on damaged fishing boats after the first wave. About 7 minutes after the first wave, a second, larger wave hit from the east carrying the burning boats into the main town. The second wave completely flooded the first three rows of houses, and runup was measured around 5-10 m throughout the town. The UJNR survey team found battery-operated clocks in this area that had stopped at 22:37 and 22:38. The combination of a strong, northeast wind, the burning boats, and an ample supply of propane and kerosene (used for heating) spread the fire quickly and destroyed 340 homes. Autopsies revealed that only two of the 114 deaths in Aonae were caused by fire. This section of Aonae was the hardest-hit developed area in spite of the fact that a massive, 4.5 m breakwater and 10 m high sand dunes were very effective in reducing the runup to 5-10 m along the southeastern tip of the peninsula (Figure 2 and photograph). In this regard, note that runup values rise rapidly again to the 10-20 m level a short distance northeast of the peninsula (Figure 2); this is undoubtedly due to the absence of breakwaters or sand dunes along this part of exposed coast.

The extent of damage to Aonae is illustrated in photographs 1 and 2. The houses in the central part of photograph 1 were flooded by tsunami waves that ran up to a height of 5 m. The area in the foreground of the photograph 1 was a residential section consumed by the conflagration. The tsunami destroyed a portion of the sea wall as seen in photograph 2. Fishing boats were left "high and dry" in the inundation zone. Photograph 3 shows a damaged automobile surrounded by debris in a residential area north of Aonae.

A similar refraction of the tsunami took place on the northern point of Okushiri Island at Inaho where 13 persons were killed and all houses were destroyed by waves that ran up over 10 m. The eastern side of Okushiri Island was less affected where the tsunami runup was measured between 2 and 5 m. Subsidence was observed by Tsuji at Aonae, Okushiri, and Monai, while uplift was observed at Inaho Point. These data again suggest that Okushiri Island was part of the deformation area, which is consistent with the aftershock data.

The tsunami also hit the island of Hokkaido (Figure 3), arriving at Ota Bay within 5 minutes of the main shock and destroying five homes. Runup in this area was 9 m. Damage

Figure 3. Legend and data presentations are the same as in Figure 2.

Hokkaido Nansei Tsunami
12 July 1993

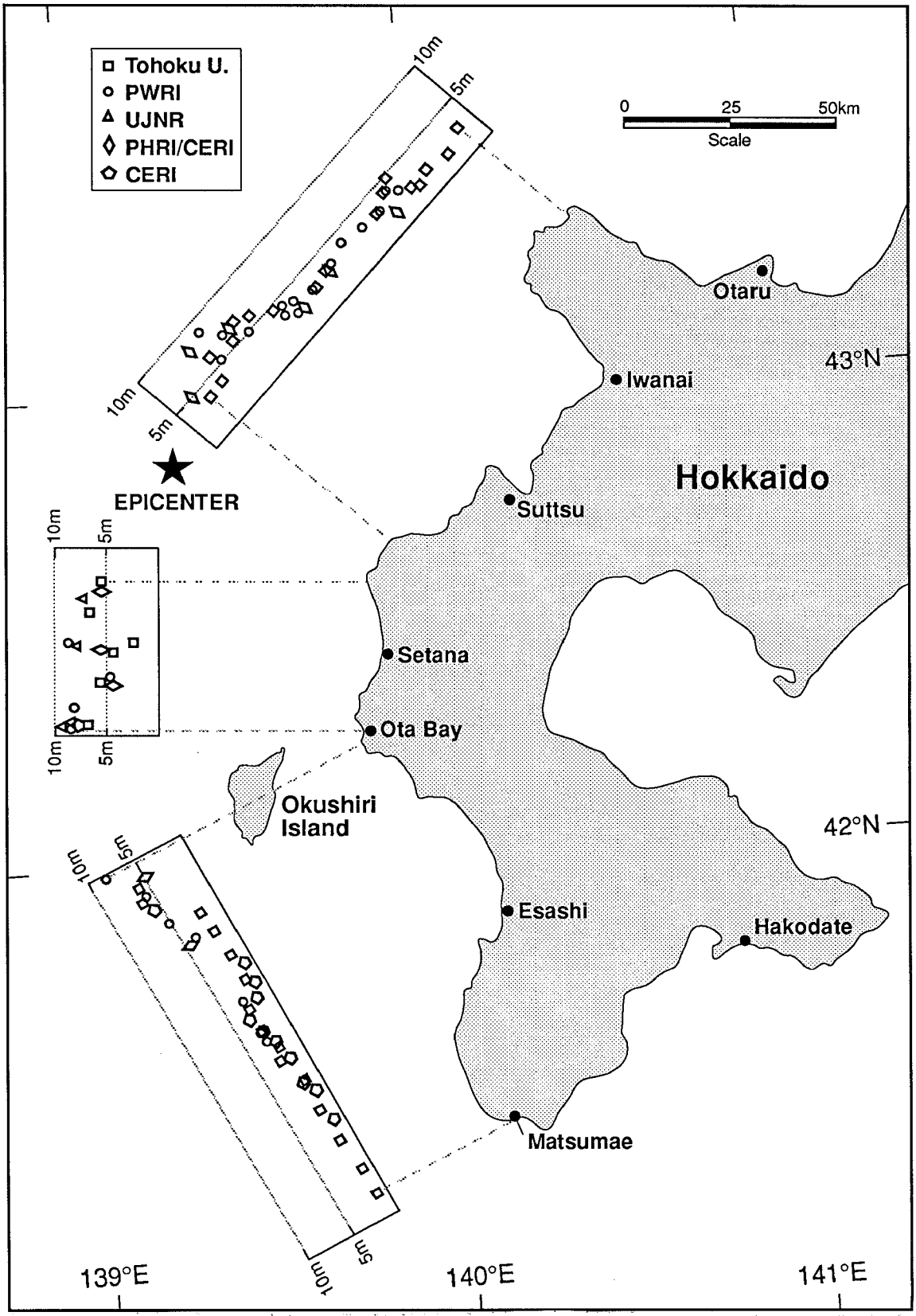


Figure 3. Survey Results, Hokkaido Island graphics: NOAA/PMEL

was also observed at Setana due to 6 m runup waves. The coastline from Suttsu to south of Ota Bay was hardest hit with runup values of 5-9 m. Outside this area, the tsunami intensity tapered off rapidly, and runup values fall below 5 m. The closet tide gauge to the earthquake was Esashi, which recorded a 2 m wave approximately 10 minutes after the main shock. Those data suggest that the eastern portion of the source was between Okushiri Island and Hokkaido.

The tsunami propagated to Russia within 30 minutes, where 1-4 m tsunami runups were reported by Valentin Fedorey (Hydromet). Damage estimates were over US$6 million. After 90 minutes, the tsunami struck the coast of South Korea, where B.H. Choi of Sung Kyun Kwan University measured tsunami runup of 1-2 m.

Summary

In summary, the Hokkaido Nansei-Oki earthquake produced one of the largest tsunamis in Japan's history. Tsunami vertical runup measurements varied between 15 and 30 m over a 20 km portion of the southern part of Okushiri Island with several 10 m values on the northern portion of the Island. Along the west coast of Hokkaido, no survey values exceeded 10 m, but damage was extensive at several coastal towns. Given the sudden onset of the tsunami and its high energy, it is amazing that more people were not killed.

Data presented in this report were collected by the following teams and members:

Tohoku University Team: N. Shuto (Leader), and H. Matsutomi
University of Tokyo Team: Y. Tsuji (Leader)
PWRI Team: H. Ito (Leader)
PHRI Team: Y. Suzuki (Leader), S. Takahashi, C. Goto, N. Hashimoto, and T. Hosoyamada
CERI Team: Y. Mizuno (Leader), and K. Yano
UJNR Team: E. Bernard (Leader), F. Gonzalez, H. Tsuruya, and K. Kato; D. Sigrist (IOC/ITSU)
JMA Team: O. Nagaoka (Leader), S. Honda, H. Tatehata; H. Uchiike (JMA Headquarters)

Earthquake Engineering Research Institute (EERI), Newsletter, Special Edition on the July 12, 1993, Hokkaido Nansei-Oki Earthquake, Oakland, California, August 1993

This inclusive report covers a variety of topics and issues including articles on the Earthquake Mechanism, Strong Ground Motion, Tsunami, Societal Issues, Fire, Structural Damage, Lifelines, Liquefaction and Landslides. A combined EERI/ UJNR team surveyed damage and other effects from the earthquake and tsunami.

The report focuses primarily on damages on Okushiri and Hokkaido islands. The team arrived in Japan on July 18, and conducted field reconnaissance and data gathering between July 20 and 24. The research, publication and distribution of the report was funded by the US National Science Foundation. For further information, call the EERC Library at 510-231-9401 in Oakland, California.

Kokusai Kogyo Co., Technical Report on the July 12, 1993, Hokkaido Earthquake, Hino Technical Office, JAPAN, Contact Mr. Yoshitaka Hayashi

This excellent in-house publication was produced by the Kokusai Kogyo Company and includes a selection of vertical and oblique aerial photographs, tsunami runup distribution, earthquake damages, engineering analyses as well as other technical information obtained during the surveys of Hokkaido and Okushiri Islands.

One excellent comparative analysis using aerial photographs shows the community of Aonae (on southern Okushiri Island) before and after the earthquake-tsunami. Not only is the tsunami runup and resulting damage clearly visible, the subsidence of the near-shore reef (up to 1 meter) dramatically reveals the nearby deformation associated with the seismic event. The Kokusai Kogyo Company was responsible for taking the aerial photographs on the day following the tsunami. Positive contact prints and diapositive transparencies of the aerial photographs are available directly from the company.

7.12 East Sea Tsunami in Korea, Report to ITSU-XIV, Sang-Jo Kim, Korea Meteorological Administration

Tsunami damage in the Republic of Korea from the July 12, 1993, tsunami included the loss or damage to 35 small ships and associated fishing equipment valued at US$490,000. The Korea Meteorological Administration issued a "Tsunami Warning" 33 minutes following the earthquake origin putting into motion the mobilization of 7,000 disaster personnel. A systematic coastal survey by B. H. Choi (Sung Kyun Kwan University) reported vertical tsunami runups of 1 to over 2 meters.

Excellent records from tide gauges showed maximum water changes up to 276 cm. An offshore tide gauge operated by the Korea Research and Development Institute detected the tsunami and tsunami induced velocities with a maximum water level change of 1 meter recorded.

NEWS EVENTS

Tsunami Runup Distribution Along the Eastern Coast of Korea, Byung Ho Choi, Sung Kyun Kwan University

Location	Latitude	Longitude	Runup Height Above LMSL
Geojin	38-26-44N	128-27-41E	0.81m
Ayajin	38-16-14N	128-33-37E	1.39m
Sajin	38-13-24N	128-35-25E	2.22m
Sokcho	38-12-14N	128-35-50E	0.91m
Daepo	38-10-21N	128-36-36E	1.63m
Osan	38-05-18N	128-39-57E	1.26m
Susan	38-05-30N	128-39-10E	1.85m
Gisamun	38-00-23N	128-44-00E	2.26m
Namae	37-56-29N	128-47-18E	1.26m
Jumunjin	37-53-00N	128-49-30E	1.46m
Sachunjin	37-50-06N	128-52-45E	1.46m
Gangmun	37-47-38N	128-55-10E	1.87m
Jungdongjin	37-40-55N	129-02-46E	2.01m
Gumjin	37-38-59N	129-03-09E	1.17m
Daejin	37-34-45N	129-30-00E	1.56m
Mukho	37-32-50N	129-07-06E	1.99m
Donghae	37-29-24N	129-08-40E	1.76m
Chuam	37-28-20N	129-09-55E	1.77m
Samchuk Beach	37-28-00N	129-10-10E	2.15m
Samchuk Port	37-26-10N	129-12-00E	1.86m
Obunri	37-26-00N	129-12-00E	1.10m
Gungchon	37-17-00N	129-18-30E	1.74m
Jangho	37-17-30N	129-18-40E	1.41m
Imwon	37-13-00N	129-21-00E	2.39m
Hosan	37-09-40N	129-21-00E	1.38m
Bugu	37-06-00N	129-22-32E	2.57m
Jukbyun	37-03-00N	129-25-40E	1.43m

CORRECTIONS

Please note the following corrections to the July 1993, ITIC Tsunami Newsletter:

Page 7. Bernard David Zetler

Zetler joined the Institute of Geophysics and Planetary Physics at the Scripps Institution in 1972.

Page 13. European Geophysical Society Tsunami Symposium - Edinburgh, Scotland, U.K. The symposium was held on April 8, 1992.

List of National Contacts

Please Note: The following list of ICG/ITSU National Contacts was last updated in September 1993. For those Contacts that do not have phone and fax numbers listed, please advise ITIC so the numbers can be added. And, with increased use of E-mail systems (such as INTERNET, OMNET, etc.), please provide this important information, too. As always, please inform ITIC whenever there are changes.

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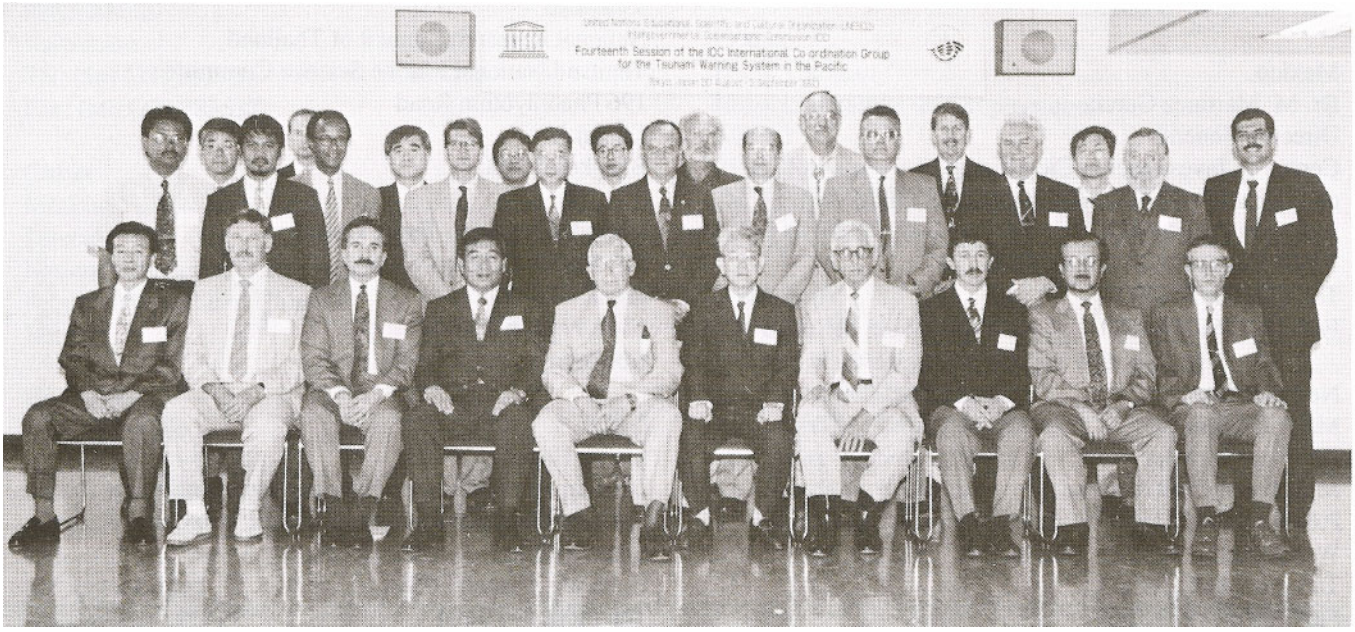
ICG/ITSU-XIV, Tokyo, Japan, August 30 - September 3, 1993

The Chairman of the Group, Mr. Richard Hagemeyer, opened the Fourteenth Session of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) on August 30, 1993, at the Headquarters Office of the Japan Meteorological Agency (JMA) in Tokyo.

Mr. Hagemeyer recalled that the first session of the Group was held almost 25 years ago and since that time the Group had accomplished many tasks which have been targeted on strengthening national and regional infrastructures of the tsunami warning system.

Representatives from 13 Member States were in attendance plus representation from the IOC Secretary, ITIC, World Data Center-A (Tsunami), and numerous observers. Dr. Kozo Ninomiya, Director General of the JMA, extended his warm welcome to all participants of the Session. Dr. I. Oliounine, the Technical Secretary of the Session, Senior Assistant Secretary IOC, thanked the Government of Japan for hosting the session and taking care of the many technical details necessary in organizing a meeting of this magnitude.

Dr. Oliounine said that the Pacific Tsunami Warning System (PTWS) is now about to embark on anew phase of its existence, in which it will attempt to anticipate Member States' aspirations, laying special emphasis on the development of regional warning centers, on improving our knowledge of the mechanism of tsunami generation and on increasing awareness amongst the population of the tsunami danger. Mr. William Sites, USA, was elected as rapporteur for the session.



ICG/ITSU-XIV, Tokyo, Japan. Group photograph at JMA Headquarters

ICG/ITSU Elects New Chairman, Re-elects Vice-Chairman

After six years of guiding ICG/ITSU, Mr. Richard Hagemeyer (USA) stepped down as Chairman of the Group at the ICG/ITSU's Fourteenth Session in Tokyo, Japan. Mr. Hagemeyer's outstanding contributions were recognized by the Group and by the Technical Secretary, on behalf of the Secretary IOC, who expressed praise for his work and devotion to the ICG/ITSU mission.

Dr. George Pararas-Carayannis was also recognized for his many contributions to the international tsunami community in his position as Director of the ITIC. The Group unanimously chose Mr. Hugo Gorziglia (Chile) as the new Chairman for the next intersessional period and next session. The Group re-elected the Vice-Chairman, Mr. H. Uchiike (Japan), by acclamation.

National Reports to the Fourteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU)

The following National Reports on Tsunami Related Activities were presented at ITSU-XIV (please note that in some instances the reports were condensed to conform with space limitations in the Newsletter:)

National Report for Australia

Introduction

The Bureau of Meteorology has been involved since 1961 in dissemination of warnings from the PTWC in Honolulu to users within Australia and its island territories of Lord Howe and Norfolk Islands, the Cocos Islands and Christmas Island, and neighboring island states such as the Solomon Islands, Nauru and Papua New Guinea. In 1986, Australia joined the ICG/ITSU.

Tsunami Risk in Australia

Australia is fortunate to have a comparatively low exposure to tsunami effects from both major seismic wave source regions (in the Pacific and to the north). Neighboring areas in the Solomon Islands and Papua New Guinea are more susceptible to locally generated tsunamis. These local tsunamis generally provide little time for warnings to be issued to the local population.

Communications Systems

Further improvements have been made to the dissemination of tsunami warnings within Australia, and between Australia and its island territories (Lord Howe, Norfolk, Christmas and Cocos Islands) and other nearby south west Pacific nations (Papua New Guinea, Solomons Islands, Nauru) using automated communications, including facsimile.

Visit by Professor E. Pelinovsky

During January and February 1993, Professor Efim Pelinovsky, from the Institute of Applied Physics at Nizhny Novgorod, Russia, visited Australia to further contacts between the two countries in the field of geophysical modeling and simulation of the generation of seismic waves, and to present a number of lectures on the subject. Professor Pelinovsky's visit was very productive, and it is hoped that it marked the establishment of firm and useful links between researchers and ITSU operational areas in Australia and their counterparts in Russia's Pacific Region.

Australian Sea Level Data Networks

The network of tide gauges in Australia consists of over one hundred tide gauges owned by various organizations. Overall coordination of sea level monitoring activities is carried out by the Permanent Committee on Tides and Mean Sea Level, which comprises representatives from national agencies and institutions (including the Bureau of Meteorology).

South Pacific Sea Level Data

Australia has funded the establishment of a sea level monitoring network in the South Pacific (South Pacific Sea Level and Climate Monitoring Project). This network monitors sea level in the environs of countries of the South Pacific Forum, primarily as part of the regional greenhouse impact strategy. It is expected to be fully operational by late 1993.

National Report for Canada

Pacific Tsunami Warning System (PTWS)

During the past two years the Canadian Hydrographic Service (CHS) has operated three tsunami warning stations on the British Columbia coast in support of Canada's contribution to the PTWS:

1. Bamfield Tsunami Warning Station

This station has been in continuous operation during the reporting period. The station presently contains an analog recorder and a single digital system, denoted as the Tidal Acquisition and Telemetry System (TATS). Both Pacific Tsunami Warning Center (PTWC) and the Alaska Tsunami Warning Center (ATWC) are able to access this gauge.

2. Winter Harbour Tsunami Warning Station

This station has been in continuous operation during the reporting period. The TATS gauge is accessible directly by either PTWC or ATWC.

3. Langara Island Tsunami Warning Station

The tsunami warning station at Langara Island has been in operation for over twenty years with no major modifications.

No tsunami were recorded at any of these stations during the reporting period.

Notification of communication tests initiated by either PTWC or ATWC, as well as summaries of these tests, are received by the CHS on a regular basis. At present, the emphasis of the tests seems to be on determining the transmission times for messages. The acquisition of water level data and the communication of this information to the warning centers needs to be given renewed attention.

Regional Preparedness

The Provincial Emergency Program has developed a Tsunami

Warning Plan for the British Columbia (B.C.) coast. In this plan, the CHS is tasked with providing information on tsunami from stations on the B.C. coast, and with providing forecast information based on results of numerical model simulations, data obtained from other stations (provided by PTWC and/or ATWC), and tidal predictions.

Regional response to earthquakes, tsunami, and other emergencies is coordinated, in part, through meetings of the B.C. Regional Emergency Telecommunications Committee, which meets at least twice per year.

Tsunami Research

Canada supports the concept of tsunami inundation modeling, and notes with regret that Recommendation ITSU-XIII.1 adopted in Ensenada has not received the requested funds from IOC. In its continuing support of inundation modeling, Canada notes that improved numerical techniques have been developed since this project was first formally proposed at the Twelfth Session in Novosibirsk.

Canada continues to be active in tsunami research and notes, in particular, the contributions made by Drs. T. S. Murty and M. I. El-Sabh in this regard. In addition to their ongoing research in this field, both individuals actively promote the study of tsunami and other natural disasters. Dr. Murty is presently the Technical Editor of Science of Tsunami Hazards, is an Associate Editor of Marine Geodesy, and is on the editorial board of two other relevant journals.

In addition, he served as leader of the UNESCO team that surveyed the Nicaragua tsunami of September 1992. Dr. El-Sabh is Editor-in-Chief of both Natural Hazards and Advances in Natural and Technological Hazards Research. He is also President of the International Society for the Prevention and Mitigation of Natural Hazards, is a member of the JAPSO Executive Committee, and is Chairman of the JAPSO Commission on Natural Marine Hazards. Dr. El-Sabh is Chairman of the International Symposium, Hazards '93, that was held in Qingdao, China in August/September 1993.

In support of studies being carried out by the Pacific Geoscience Center (PGC), Sidney, B.C., to monitor crustal deformation on Vancouver Island, the CHS maintains a network of fourteen water level stations to obtain information on rates and trends of sea level change.

Training and Education

In the last few years there has been compelling evidence that megathrust earthquakes occur along the Cascadia subduction zone. This area is unusual in that it has been quiet in recent centuries, despite having the geological characteristics that in other parts of the world are active.

The recent earthquake near Cape Mendocino (April 1992), and the resultant tsunami, have served to focus attention to this area. Although no subduction earthquakes have been reported in this area in recent times, the Cape Mendocino earthquake (at the edge of the subduction zone) shows that the two zones are locked and strain is building.

Much of the public education for earthquake preparedness is provided by staff of the PGC. As part of the public education program, all telephone directories for communities in B.C. coastal areas contain information on earthquake and tsunami response.

National Report of Chile

Introduction

This report summarizes the activities of the Chile National Tsunami Warning System (NTWS) since the Thirteenth Session of the ICG/ITSU, held in Ensenada, Baja California, Mexico. The Nicaraguan Tsunami of September 2, 1992, was recorded during the reporting period at the Easter Island tide gauge.

Instruments Upgrade

No other tide gauge station has been installed during the reporting period. The actual figures are: 17 permanent tide gauge stations, seven of them are equipped with satellite Data Collection Platforms (DCP).

The seismographic coverage in Chile is still poor in regions of the central part of the country. The acquisition of a broad band system to be installed at the NTWS Office is under consideration.

Communications

Provisions have been made to adapt the APT satellite group station to receive DCP data, getting a faster acquisition capability independently of the actions taken by PTWC.

An agreement has been reached with the Peruvian Navy to interchange tsunami information caused by earthquake activity in Peru - Chile.

National Report of Colombia

Colombia's Pacific coast faces in all its extension the northern most segment of the South American subduction zone. The historical record, although very short, includes five local tsunami since 1868; two of these (1908 and 1979) were very severe with tolls of several thousand lives. The last one, in 1979, drew wide attention to the fact that the country's tsunami warning problem had to be solved locally. Indeed, historical analysis did not show any evidence of far-source tsunami impact.

After centuries of marginal development, this coast has recently experienced increasing growth; major infrastructure projects are now boosting development even more. These facts and recent confirmation of hazard by earthquake predictions from several sources, led several years ago to the initiation of an integrated mitigation project, engaging local, regional and national organizations of the "Sistema Nacional de Prevencion y Atencion de Desastres" and coordinated in the multi-institutional "Comite Tecnico de Alerta de Tsunami" (Comision Colombiana de Oceanografia). Most of its activities during the first phase are focused on the southern part of the coast, where the town Tumaco (population 80,000) is at major risk.

The evaluation aspects of the program (seismicity studies, detection and warning system, propagation modeling, exposure

and vulnerability analysis) are based at the "Observatorio Sismologico del Suroccidente - OSSO (Universidad del Valle, Cali), which has been operating a regional telemetered seismic net for seven years. OSSO also engages in public information and education programs, technical advice for infrastructure projects, etc.

This project segment includes close cooperation with Ecuador, which shares with Colombia the source of hazards. The installation of the detection and warning system started in 1991 with initial funding from CIDA, Department of Humanitarian Affairs (DHA)-United Nations Disaster Relief Coordinator Office and the United Nations Developing Program, and recent major funding from the national budget. It shall be operational in less than two years.

Its basic scheme includes a windowed prediction concept (recurrence, intermediate-term earthquake prediction, deformation monitoring parent earthquake) and the detection methodology proposed and tested in French Polynesia by Okal, Talandier and Reymond. It should be pointed out that earthquake prediction information, well managed as it has been, became an important factor, giving momentum to the mitigation program.

OSSO cooperates on technical and scientific aspects with several foreign institutions (Instituto Geofisico - Quito; Swiss Federal Seismological Service/ETH Zurich; Int. Inst. of Earthquake Prediction Theory and Mathematical Geophysics, Moscow). The program has been receiving strong support, participation and even initiatives from many sources (Colombian Navy, Municipalities of Tumaco and Buenaventura, CVC, and others). Several municipalities have been active on urban development planning, emergency planning, educational programs, etc. Colombia's participation at the recent International Union of Geodesy and Geophysics (IUGG) and ITSU Tsunami Meetings (Japan) was funded by one of the coastal communities (Tumaco).

Some structural mitigation segments of the program are already financed and in process: resettlement of more than 3,000 exposed families in Tumaco (with partial funding from the European Community) and earthquake and tsunami compliant coast-wide lifeline project (water supply and disposal). This includes improvement of main bridges and roads and reclamation of energy-absorbing coastal features. The program has already shown that anticipated risk-oriented action also improves socioeconomic conditions.

National Report of the Russian Federation

Introduction

The Far-East coast of Russia is subjected to the effects of tsunami waves, generated both in the immediate vicinity of the Russian shores (in the Kuril-Kamchatka trench area and in the Sea of Japan) and by remote sources. The inter-departmental Tsunami Warning Service (TWS) operating in Russia was organized after the destructive tsunamigenic earthquake of November 4, 1952, which took place near Kamchatka and the North Kuril Islands.

The Russian Tsunami Warning System (RTWS) exercises control of seismic activity in the Pacific, detection and estimation of magnitude and tsunamigenity of submarine earthquakes, and control of tsunami phenomena developments. Its goal is to provide warning to the population and organizations of the Russian Far East about tsunami threats.

Structure of the National Tsunami Warning Service

There were several institutions in Russia responsible for the undertaking of the tsunami warning problem.

The Russian Federal Service for Hydrometeorology and Environmental Monitoring coordinates the activity of RTWS, carries out registration of sea-level variations, and organizes tsunami-threat warning of local authorities, of major economic organizations and population on the basis of seismic and tidal data. The Academy of Sciences provides round-the-clock operational work of the System's seismic stations and is responsible for the seismic aspects of tsunami warning. Operational seismic observations are carried out by 5 seismic stations of the Academy of Sciences: the central station in Youzhno-Sakhalinsk, Kurilsk and Malokurilskoye.

After raising the tsunami threat alarm, sea-level variation operational observations and control are organized in 25 shore stations of the Russian Far East. Three independent Tsunami Warning Centers situated in Youzhno-Sakhalinsk, Petropavlovsk-Kamchatsky and Vladivostok provide estimation of the tsunami threat to the Russian shores, calculation of tsunami arrival time to the shore, estimation of the wave height and dissemination of tsunami threat warnings. These centers are responsible for the tsunami warning in their respective administrative regions (Sakhalin, Kamchatka and Primorsky Kray regions respectively).

Development and Modernization of the National Tsunami Service

During the last intersessional period (1991-1993), work on the fundamental modernization of the NTWS was carried out. Its strategy had been determined by the results of the system's first phase experimental operation and by the Tsunami Inundation Modeling Exchange (TIME) project and included:

- transition to the new means of obtaining, collecting and processing information to new information technologies;
- development and introduction of software for predicting dynamic characteristics of tsunami
- development of seismic and sea-level observational networks in the northwestern Pacific where the information is insufficient;
- gradual integration of the RTWS into the international TWS;
- transition of a qualitatively new means of communication, primarily satellite channels.

Tsunami Events

There were no strong tsunamigenic earthquakes in 1992 near or in remote zones with impacts on the Russian Far East coasts. A strong earthquake was registered on July 12, 1993, which caused a tsunami on Russian Primorye coasts with wave heights

of up to 4 meters. The TWS reacted timely and smoothly.

National Report for Costa Rica

Costa Rica Operating Gauges

The Costa Rica tidal network is being implemented with the aim of monitoring climate change and seismic activity. Presently, there are two gauges (Limon and Quepos) sending data on a regular basis to Tropical Oceans and Global Atmosphere (TOGA) and Global Sea-Level Observing System. At Quepos there are in fact two gauges, both well type, analog and punch paper recorders. Caldera gauge is replacing the Puntarenas. At this site the gauge had to be removed as a consequence of local duck damage. Cuajiniquil (Station Elena Bay) is a new recording site being tested. Coco's Island gauge will transmit real-time data (via satellite) from November 1993. We expect in place Rincon's gauge sometime in 1994.

Future gauges for seismic control, at both sites of the Peninsula de Nicoya, have been chosen as a consequence of the seismic characteristics of this area. The idea is to obtain additional seismic activity information from both sides of the Peninsula. For this purpose, support has been requested to Holland in order to obtain two 1 mm drift tide gauge for these sites. From 1994, we hope to begin with the continental stations automation process, leading to a real-time information delivery to our institute in San Jose.

Recorded series length

Puntarenas (since 1940), Limon (since 1948) and Quepos (since 1957) have a long sea level data series. Unfortunately, during the 1970's the original marigrams were destroyed, so what we have is monthly values up to 1971. From 1993, for most of the period, we have preserved the analog recordings. In fact, right now Quepos is the most reliable, long and continuous series: (1971-1993). Limon series was interrupted in 1980 and then was restarted in 1992. Puntarenas gauge was removed in 1981, it was replaced in 1990, but it had to be removed again in 1993. This site's gauge has been substituted by Caldera's gauge.

Personal Comment

It is indeed urgent to consolidate an effective regional sea level network, able to respond to local needs and to the international community as well. Special interest has been paid on the effective regional states participation on the future ITSU meetings, so we can discuss plausible strategies to effectively produce a regional seismic control and tsunami warning system. Particular attention has to be focused on regional reliable sea level data control and E-mail capabilities allowing to match these goals.

National Report of the Democratic People's Republic of Korea

Activities of the National Tsunami Warning System (NTWS)

The Government of the Democratic People's Republic of Korea (DPRK) recently established the State Environmental Commission (SEC) combining with other institutions related to the environment. The SEC commenced operation on work January 1, 1993. The SEC is in charge of all work in the field of meteorology, hydrology and oceanography including the research on environmental science, environmental monitoring and its protection. Therefore, the National Tsunami Warning Activities are being implemented in the Central Weather Forecasting Institute under the management of the SEC, DPRK.

The main components of the NTWS are as follows:

- The National Tsunami Forecasting and Warning System
- The National Tsunami Communication System
- The National Sea Level and Earthquake Observing System
- The National Storm Surge Hazards Protection System

The Central Weather Forecasting Institute under the SEC plays the role of the Tsunami and Storm Surge Warning Center within the NTWS.

This Center receives the tsunami information and warning from PTWC, and assesses the risk of tsunami and storm surge and then takes the necessary measures such as issues of forecasts and warnings on the basis of earthquake and meteorological data observed from the seas surrounding our country. National tsunami and storm surge warnings are communicated immediately to the institutions concerned with the damage protection activity. The exchange of tsunami information and warning data are being regularly performed through the Global Telecommunication System (GTS).

In our country, information on the earthquake in the Sea of Japan that occurred on July 12, 1993, was received at 23:10 minutes from Tokyo through GTS.

The coastline of Korean East Sea began to be affected by the tsunami from 23:30 minutes on July 12, 1993, and in Chongjin Port, it was recorded that the maximum water table was 2.1 meters between 00:15 and 00:30 minutes on July 13.

Considering this event, we think that communication measures to accomplish the International TWS should be set up for more rapid tsunami information dissemination.

Tsunami Study

The Seismological Institute was established to regularly observe earthquakes and their study, and the forecasting and warning system of storm surge. We are implementing theoretical research on tsunami and storm surge. Recently, "The Earthquake Forecasting Chart of Korean East Sea" was published and the tsunami research model was accomplished to use in the tsunami warning. We are now studying the tsunami calculation method and discovering the detailed occurrence structure of tsunami. The numerical wave model has been developed for storm surge within typhoon.

Future Plan

1) To improve the communication system so that the tsunami warning can be transmitted to coastal areas of east and west from the National Weather Forecasting Center in Pyongyang.

2) To develop a more simplified model on propagation of tsunami and its coastal effects.

3) To train tsunami experts in the shortest period of time.

National Report of Ecuador

Activities of Instituto Oceanografico de la Armada (INOCAR): Tsunami Studies in Ecuador

Due to the economic limitations of our country, the results achieved so far have been made possible through the economic support of the United Nations. This has included the funding of various studies to mitigate tsunami hazards in Ecuador.

Studies Undertaken

Along three sections of the continental coast of Ecuador, studies were made to determine possible effects of a typical tsunami on different population centers. Inundation maps were prepared for three cities and refuge areas were identified for evacuating the local populations. Also, estimates were made for the height of the tsunami and arrival time at the three population centers.

Technical Reports and Articles

Three technical reports were prepared and delivered to the Office of National Civil Defense (NCD). These included:

1) Possible Effects of a Tsunami on the Coast of the Peninsula of Santa Elena, Ecuador (1988)

2) Evaluation of Tsunami Risk on the Populations of the Central Coast of Ecuador (1991)

3) Potential Effects of Tsunamis on the North Coast of the Province of Esmeraldas, Ecuador (1992)

One article was published: Espinoza, J. Earthquake-Generated Tsunamis of Ecuador. Acta. Oceanografica del Pacifico, Vol. 7, No. 1, 1992, INOCAR.

Other Activities

The NCD has organized several lectures and conferences concerning tsunamis in Ecuador as part of the decade-long IDNDR. An evacuation exercise was undertaken in 1991 by a portion of the population of Salinas. The exercise was conducted by the Office of NCD and the Provincial Civil Defense of Guayas. Another exercise was conducted in cooperation with Colombia as part of the "Good Neighbor Agreement" and was presented at the Workshop on Natural Disasters. An instruction manual for personnel at INOCAR who receive messages from PTWC was completed. The manual contains basic information on the formation, development, and effects of a tsunami, and examples of types of messages and how to respond. This manual will assist INOCAR staff in reading and responding to PTWC's messages as well as provide a basis for expediting the rapid transfer of messages to appropriate personnel and the civil population. It is hoped funding will be obtained in 1994 to undertake a tsunami risk study for the area including the Province del Oro and the south coast of the Province del Guayas.

National Report of Fiji

Introduction

This report outlines events of the last four years instead of the normal two years, as no report for the period 1989-1991 was submitted.

Activities

National Disaster Awareness/Preparedness weeks were held in 1991 and 1992. Both events were held during the month of September so that the activities were close to the beginning of cyclone season in Fiji. This is an annual event which began in 1989, but it was not held in 1990, due to the reorganization of the disaster response agency. During the week, information on tsunami was distributed extensively. This was in the form of displays, talks and pamphlets. The news media were also used to distribute the information.

A tsunami pamphlet, based on ITIC information, was prepared to suit the local situation. The pamphlet received wide acceptance. Tsunami response planning guidelines were also recently prepared for the Disaster Management Council of Fiji to use in the Disaster Response Planning. At present, the Red Cross Society of Fiji is preparing a "Disaster Preparedness Manual for Secondary Schools" and this will also have a section on tsunami disaster preparedness.

Tsunami Communication

Tsunami messages are still received from PTWC through Nadi Meteorological Services and passed on to the Director of Mineral Development for appropriate action, but some internal changes are being planned for the dissemination of the messages. The changes will take place when a national disaster response plan is prepared, which at present is being developed.

Tsunami Monitoring

The Mineral Resources Department operates 10 short period seismograph stations which have become old and difficult to maintain. It is therefore planned to replace them with modern digital seismographs. Incorporated Research Institutions for Seismology will establish a broad band seismograph station in Fiji later this year which we will be able to use for tsunami prediction using an algorithm developed by French scientists from Tahiti. Several broad band seismograph stations will be temporarily established in the South Pacific by Washington University (US) for regional tectonics studies. Three of these stations will be located in Fiji. The available data will also become useful for tsunami and crustal studies in Fiji.

National Report of France

France has been working actively on the development and testing of the T.R.E.M.O.R.S. system. This system, developed by the Laboratoire De Geophysique (LDG), automatically determines the location and magnitude of large earthquakes that might be involved in tsunami generation. Tests have been conducted on far field and near field seismic records from LDG and GEOSCOPE stations. Results are conclusive in both cases and have been presented at the Wakayama International Tsunami Symposium (Tsunami '93). The Tahiti office of LDG has been using the system routinely for about two years. The large tsunami earthquakes of the last twelve months have been detected and the seismic moment correctly evaluated on a real-time basis. This system should be particularly suited for countries with no or little seismic equipment.

LDG has developed new software for non-linear modeling of wave generation and propagation close to the coast and also of runup in three dimensions. These are based on Mader's 2-D and 3-D software with refinements developed for describing ocean bottom motion and coastal slope motion. Modeling of sediments or rock motion along the slope is presently under development. It will be checked against lab experiments.

National Report of Indonesia

Introduction

Since 1991, only one large tsunami has attacked Indonesia, and that was the Flores earthquake-tsunami of December 12, 1992. This event caused 1,974 deaths, 502 people heavily injured and 1,624 slightly injured. A number of 28,386 buildings were totally or heavily damaged, 4,382 buildings slightly damaged. Tsunami was observed along north coast of Flores with maximum height of 26.2 meters in Reangkroko (East Flores Regency). Tsunami caused severe damages in southeast and south Sulawesi Provinces, it was also observed in Molluca Province.

Seismological Network

The Indonesian Meteorological and Geophysical Agency (MGA) is the only institute in Indonesia which is charged with handling seismological observations. The activity has been carried out for more than 85 years. At present, MGA operates 55 stations which consist of 28 non-telemetered stations and 27 telemetered stations. MGA's telemetered seismological network has been operating since October 1991. This system has improved MGA's capability to give early earthquake information in order to mitigate the disaster that might be generated.

Tide Gauge Station

Up to now, tide gauge stations have been established by the Research and Development Center of Oceanology, National Coordinating Mapping and Survey Board, Naval Hydro-Oceanographic Office. Unfortunately, most of the agencies are not continuously manned to observe the tidal variations.

Organization

Efforts need to be focused on the management before, during, or after the occurrence of natural disasters, thereby involving activities of prevention, attenuation, rescue, rehabilitation and reconstruction. The President of the Republic of Indonesia has stipulated a decree on the National Coordinating Board for Disaster Management to manage the efforts associated with mitigating natural disasters. This board is chaired by the Minister of Coordination of Social Welfare.

Future Plan

Up to now, Indonesia has not had a regional TWS in Indonesia. The existing telemetered network would facilitate the possibility of establishing a TWS in the future. It is planned in the near future to extend the telemetered seismological network by adding more sensors. This extension of the network will include as well seismic real-time processing at the National level of MGA. Indonesia has submitted a proposal to IOC in 1989 for the establishment of a TWS in Indonesia. It is strongly hoped this proposal would be considered for implementation in the near future.

National Report of Japan

Introduction

The Japan Meteorological Agency (JMA) has been providing a systematic tsunami forecasting service for Japan since 1952 and cooperating with other Pacific countries in the PTWS since 1968. Japan has been making a great effort to improve tsunami forecasting procedures over the years. JMA maintains various types of seismographs throughout the country for continuous earthquake observation. Most of the seismic wave form data are telemetered to the six Regional Tsunami Warning Centers (RTWCs); Sapporo, Sendai, Tokyo (Headquarters), Osaka, Fukuoka and Okinawa through dedicated cables on a real-time basis, so that JMA can detect most of the earthquakes with magnitude three or more in and near Japan.

When a large earthquake is recorded at any station in Japan, the seismic data are quickly analyzed to estimate its hypocenter and magnitude both automatically and interactively. If the hypocenter is located in an oceanic area within 600 km of the coast of Japan, with shallow depth and magnitude large enough to generate a tsunami, forecasts on a tsunami are issued by the RTWCs for their responsible coastal areas. These forecasts are disseminated to the related organizations such as local governments, law-enforcement and broadcasting media through computer communication links and/or facsimile devices which can send information to 100 receivers simultaneously.

The Headquarters of JMA also issues tsunami forecasts for earthquakes occurring in areas outside the 600 km of the coasts of Japan, through the exchange of data and information on the earthquake and tsunami concerned with foreign observation stations and tsunami centers such as the PTWC.

Recent and Historical Tsunami Activity

As reported in several publications (for example, EOS, August 24, 1993), a devastating earthquake of magnitude 7.8 occurred off the coast of southwestern Hokkaido Island on July 12, 1993. Although the seismicity in the Japan Sea side of Japan is lower compared with the Pacific side, shallow earthquakes of magnitude greater than or equal to 7.4 occurred in the Japan Sea in 1940 (off Shakotan Peninsula), 1965 (off coast of Niigata prefecture) 1983 (mid-Japan Sea) and now in 1993. The 1983 earthquake occurred adjacent to the epicenter of the 1993 event. The 1983 event was responsible for significant property damage and the loss of 100 lives.

On the evening of July 12, 1993, the Sapporo District Meteorological Observatory, of the JMA, issued a tsunami warning within 5 minutes of the earthquake origin time. Unfortunately, the tsunami attacked Okushiri Island within a matter of minutes. The maximum tsunami runup height was reported at 22 meters on the southwestern coast of Okushiri Island by the JMA survey team. More than 200 people were killed and lost by the earthquake and successive tsunami. Many people which survived the tsunami on Okushiri Island mentioned the lesson

learned from the 1983 Japan Sea earthquake and resulting tsunami that struck Okushiri Island. They responded to the violent shocks and evacuated low lying areas as soon as possible.

The JMA procedure for tsunami warnings in the present system takes about 30 minutes to disseminate warning information for near-field events to the international community. A minor change in the procedures will shorten the time of dissemination.

National Report of Mexico

Tsunami Inundation Modeling Exchange (TIME) Project

Thanks mainly to the efforts of Dr. Nobuo Shuto from Tohoku University, Japan, TIME technology transfer to Mexico started with the following:

1. Dr. Shuto transferred to a computer at Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE) in Ensenada, Mexico, the numerical model programs for near field tsunami inundation, including effects of runup and structures, and far-field tsunami propagation.

2. Under the Japan-Mexico Exchange Program for Scientific Training, the Japanese International Cooperation Agency (JICA) supported a six-month stay for Mr. Modesto Ortiz of CICESE at the Disaster Control Research Center (Tohoku University). This six-month stay allowed Dr. Shuto to expand the original training program to include field surveys (at the site of the unexpected Hokkaido Nansei-Oki tsunami) to compare numerical results with actual measured runups, how to judge the computed results, tsunami protection measures, and other research applications. The inundation maps produced by this project will be used for tsunami hazard planning by civil protection agencies of Mexico. CICESE and the Representatives of Mexico to this Session are very grateful for Dr. Shuto, Tohoku University, and JICA. We suggest other developing nations interested in TIME, explore the possible support of JICA.

Catalog of Tsunamis in the Western Coast of Mexico

In support of a recommendation made at ICG/ITSU-XIII, and after the request of the IOC Secretariat, the WDC-A for Solid Earth Geophysics published and distributed the bilingual (Spanish-English) Catalog of Tsunamis in the Western Coast of Mexico, authored by A. J. Sanchez and S. F. Farreras, as a contribution to the International Decade for Natural Disaster Reduction (IDNDR). James F. Lander from the University of Colorado and the National Geophysical Data Center (NOAA) editorial staff reviewed the English text and provided editorial help.

ITIC Brochure in Spanish

After a few modifications made to improve and update the English version, Mr. Farreras and Mr. Sanchez translated the ITIC brochure to Spanish and submitted it to ITIC and the IOC Secretariat on March 1992.

Extension of Sea-Level Network and Participation in the PTWC

With the cooperation of the Sea and Lake Levels Division (SLLD) from National Ocean Service (NOS)/NOAA, who provided the equipment and support for the installation, Manzanillo and Socorro Island were furnished with Geostationary Operational Environmental Satellite (GOES) Data Collection Platform (DCP). PTWC installed also a DCP at Socorro Island. These sea level reporting stations are in addition to Cabo San Lucas, equipped by TOGA/University of Hawaii that is already in operation. Guadalupe Island station, destroyed by a tropical storm at the end of 1991, will be soon reconstructed by NOS (NOAA). Installation, maintenance, and operation of the stations is made with the help of the Pacific Operations Section of SLLD. Data from the 3-hour interval files of Manzanillo and Socorro Island stations, are accessible to CICESE and the Mexican Navy from a special courtesy directory on the National Environmental Satellite Data, and Information Service (NESDIS)/NOAA computer. The Manzanillo station can be interrogated in real-time via modem by the Mexican Navy. NOS (NOAA) and TOGA/University of Hawaii provided training courses in the sea-level equipment and data processing to CICESE's personnel. CICESE and the Representatives of Mexico to this Session are very grateful to the director and staff of the SLLD (NOS/NOAA), its Pacific Operations Section, NESDIS/NOAA, and Dr. Klaus Wyrtki and Dr. Gary Mitchum from TOGA/University of Hawaii.

National Report of New Zealand

Tsunami Activity

No tsunamis have been detected or reported in New Zealand waters since the last national report was forwarded in July 1991. New Zealand has participated in: 1) twenty-nine Tsunami Bulletins; 2) nineteen Tsunami Dummy; and 3) eleven Tsunami Communications tests within New Zealand and communications exercises with PTWC, Hawaii, during the last two years.

Reporting Equipment within New Zealand

The Chatham Islands Data Collection Platform (DCP) has been out of action for a short period due to storm damage, and the rebuilding of the wharf where the equipment is housed. In June/July 1993, a technician from PTWC visited the Chatham Islands and carried out maintenance of the equipment.

The remaining two tide-gauges at Lyttelton and Whangarei are continuing to function effectively. The proposed fourth site for a DCP at Raoul Island is still receiving attention and logistic study. Because of the remoteness of the island from New Zealand and the severe weather that can be experienced in the area, the equipment and the housing will probably have to be developed in New Zealand and transported for installation to the site. It is anticipated that this will be progressed during the next financial year.

The New Zealand National Scientific Advisory Committee

The Committee continues to function effectively and received favorable comment in the recent review of civil defense. The working groups which deal with the respective hazards

continue to operate and have provided scientific input into the planning, research and contingency planning that is being undertaken.

Pitcairn Island

In response to formal request from the Consulate General of the United Kingdom in Auckland, the Ministry of Civil Defense has passed tsunami warning messages to the Chief Administrator for Pitcairn Island. Recent communication development between PTWC and Pitcairn Island indicate that this procedure being carried out by new Zealand may no longer be required. Should this be the case, then a formal amendment to the Communication Plan for the TWS for the Pacific should be issued.

Post-Graduate Research

The post-graduate research mentioned in the previous report which was being undertaken by the University of Waikato into the effects of tsunami activity on the Bay of Plenty and Coromandel coasts has been completed. After evaluation, it is intended that the document be printed and made available to the National Scientific Committee for their use.

Public Education

A National Public Education Advisory Group has recently been established. It is the intention that this group will study the Public Education and Awareness material that is being considered under Agenda Item 8.1 of the Session. From this, it is anticipated that the ideas proposed by ITSU Working Group may be used in its entirety, or form part of any future awareness documents produced within New Zealand.

Visits

In May 1992, the Chairperson of the Tsunami Working Group, Professor T. Healy, and the Civil Defense Commissioner in Auckland, Mr. G. G. Elder, visited the Seismological Observatory in Tahiti. Discussions were held with the Director, Dr. J. Talandier and his staff. Mr. M. Blackford, Geophysicist in Charge, PTWC, was also in attendance. There was an exchange of information together with the demonstration of the T.R.E.M.O.R.S. system developed by Dr. Talandier and his colleagues.

National Report of Nicaragua

Introduction

The Pacific coast of Nicaragua, which lies in a northeast-southwesterly direction, with a length of 305 km, experienced the effects of a tsunami on September 1, 1992, 19:15 local time, whose shock waves reached as far as the Galapagos Islands, with severe consequences for the coast.

According to official versions from the Nicaragua Civil Defense, the loss of human lives was calculated at 105, with 63 missing, 489 injured, more than 13,000 people without accommodation and the destruction of 773 houses in 23 population centers.

Actions Taken to Mitigate the Effects of Future Tsunamis

1. Relocation of the Population.

In fourteen population centers the destroyed houses were relocated in the same settlement, but to more secure sites. New settlements were located far from the coast, where the houses destroyed in the population centers of Corinto, Los Brasiles, Salinas Grandes, Salamina, Popoyo and Santa Ana were relocated; and three new settlements were rebuilt in more secure sites and linked to new economic activities.

In other three localities a zoning system was created for use of the land, in which key elements of territorial planning were defined such as: urban structure, productive activities, infrastructure, housing and equipment in order to propitiate the future development of these urban centers in safer areas.

2. Faster Processing of Seismic Information.

The "Instituto Nicaraguense de Estudios Territorialses" (The Nicaraguan Institute of Territorial Studies), INETER, measured seismic data with processing instruments that were largely obsolete until the middle of 1992, which generally demanded more than thirty minutes to find out the characteristics of the seismic events that were occurring.

Starting from November 1992, this limitation was overcome thanks to a Digital Processing System, donated by the Norwegian Government, and by the increase in the number of telemetered seismic stations, with which Nicaragua has succeeded in reducing the information processing time, thus allowing a determination of the epicenter and characteristics of a seismic occurrence in just 15 minutes. This time will be reduced by the end of this year to 10 minutes, after the improvement of the system's software.

3. Seismological Shift.

The establishment of the Seismological Shift involved the creation of a permanent Vigilance Office operating 24 hours a day in INETER, which started in November 1992. This action was taken in order to immediately satisfy the demand for information related to any seismic or volcanic event, and to alert the civil defense authorities, mass media, and the population in general about natural disasters.

4. Affiliation to the ICG/ITSU.

After the occurrence of the tsunami, our country started negotiations before the IOC of UNESCO, in order to become affiliated with the ICG/ITSU for the PTWS. At the beginning of 1993, the IOC officially announced the acceptance of Nicaragua as the twenty-sixth Member of the System. The General Director of INETER was designed as the National Contact of Nicaragua.

For the first time in history, Nicaragua participated in a meeting of the IOC at ITSU-XIV in Tokyo, Japan.

Actions to be Taken in the Immediate Future.

1. Rapid Communication System

An agreement was recently established for technical cooperation between the Swiss Cooperation for Development Organization, the Nicaragua Civil Defense and the Nicaraguan INETER. The agreement foresees the installation of a rapid communication system in order to give out warnings with preventive aims to the main centers on the Pacific coast.

2. Education Campaign About Tsunamis for the Coastal Population.

Through INETER and the Ministry of Education, different actions have been carried out to prepare pamphlets and graphic information directed at the coastal population of the Pacific Region, as an educational activity for future tsunamis.

National Report of Peru

Background

Peru, as one of the countries integrating the Pacific Tsunami Warning System (PTWS), has developed, during 1991-1993 important activities with the aim of improving its National Warning System and the Public Education by disseminating information concerning the occurrence of tsunamis in the coast and its effects.

The creation of the National Tsunami Warning System (NTWS) in Peru dates back to 1970. That year, the country joined the PTWS and designated the Peruvian Navy, Hydrographic Office (DHNM) as its official national representative to this international body.

The Peruvian Commercial Airports Corporation (CORPAC) Office administers the International Airport safety communication net. The DHNM keeps a dedicated telex line with CORPAC to receive and transmit all tsunami and tsunami dummy messages via this line. As a backup, we also keep a commercial telephone line and a magnetic dedicated line with CORPAC.

The Peruvian Geophysical Institute (PGI) manages the seismic network of the country, and reports to our office information regarding the epicenter and intensity of earthquakes occurring in our territory. When necessary, this information is rebroadcast to Honolulu. The DHNM maintains a dedicated telephone line and a fax line with PGI for this purposes.

The DHNM has signed a cooperation agreement with The International Seismic and Disaster Mitigation Center (CISMID) in order to exchange seismic information relevant to our tsunami activity. For this purpose, an automatic seismic station has been installed to record events of intensity 6.5 and greater. This information is recorded in magnetic tape and processed in CISMID to analyze the local effect and intensity of earthquake in the urban area of Lima.

The National Civil Defense Office is responsible for channeling the tsunami warnings to local authorities for purposes of evacuation of coastal areas. The Peruvian Navy, via its communications network, cooperates with Civil Defense by transmitting tsunami warning messages to Port Captains along the coast, who are part of the Civil Defense system. Civil Defense also coordinates with DHNM plans and exercises of evacuation in highly populated or risk zones. The Tidal Station Network comprised of eight stations is managed by the DHNM as part of the NTWS.

Two simulated evacuation exercises were carried out in La Punta and Callao, with the school population and coordinated by Civil Defense, in order to increase the awareness of the population. Other institutions participating in these events were the national police and firemen company and the Red Cross.

Communication exercises via the Naval net are also carried out regularly, to train operators and improve the travel time of tsunami messages. General information and bulletins (information material) has been elaborated in coordination with Civil Defense to be distributed to all population in coastal areas.

The DHNM received an important contribution from the Peruvian Science and Technology National Board and the US Agency for International Development for the elaboration of an educational video on tsunamis. This is being broadcasted by national TV networks for the general public. A pilot project will be carried out with several schools in order to test the use of this film, by broadcasting the video and requesting schools to take a prepared test by students. The video was produced by the TV Educational Center of the Catholic University of Peru. A copy of the film in Spanish language will be sent to the ITIC for general use.

National Report of the Philippines

Overview

The Philippines is one of the Member States of the IOC-ICG/ITSU. The probable area where tsunamis are most likely to occur is the eastern part of the Philippine archipelago. This area is susceptible to such danger in view of its location and proximity to the volcanic and earthquake belt in the Pacific area. The configuration of the Pacific Ocean has numerous faults, ridges, and fractures which are contributing factors to the generation of a tsunami. Earthquakes have generated destructive tsunamis in the past. Recent earthquakes and associated tsunamis in the Philippine Islands killed and/or injured people in 1989 and 1990. The powerful earthquake of July 16, 1990, (M_S=7.7) killed more than 1,600 people in the northern Philippines.

Tide Station Network

The National Mapping & Resource Information Authority, an attached agency of the Department of Environment and Natural Resources, is the sub-committee for Tsunami cooperation in the Philippines and is the responsible agency for maintaining the national network of ten tide stations previously operated by the Coast & Geodetic Survey Department. All stations are constructed on piers or wharves, the deck of which are at least two meters above mean high water; four of which are equipped with an A. Ott tide gauges, and one with an Aanderaa pressure gauge. Five of these stations were established under the Association of South-East Asian Nations-Australia Marine Science Cooperative Programme and were provided with new tide house and instruments of combined analog type gauges (Leupold & Stevens) and Endeco pressure type gauges.

Network of Tide Stations in the Philippines

Legaspi tide station is also a tsunami station and has a direct communication with the PTWC in Honolulu, Hawaii, and with relevant national organizations. Except for Port Irene, all other stations are near established communication facilities.

Seismic Observatory Network

The operation of the seismic observatory network has been transferred from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) to the Philippine Institute of Volcanology and Seismology (PHIVOLCS). Twelve seismic stations are in operation and equipped with seismometers of the traditional smoke-recording type. PHIVOLCS has a long term plan to establish a country-wide network and to upgrade existing stations. These stations should be equipped with appropriate broad band seismometers and computer interphasing which permit rapid calculation of seismic event.

The Office of Civil Defense has the responsibility for public education and disaster warning dissemination and of alerting search, rescue and relief component units of local agencies of the impending force of tsunami. PAGASA maintains an extensive national and international communications network.

Future Plans

The Sea Level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) was originally developed for the U.S. NOAA/NOS for use in its global observing system. This field unit is known as the Next Generation Water Level Measuring System. The primary requirement for this unit is the accurate measurement of tide and sea level information. This system uses high technology-sensors and microprocessor-based data collection and recording system with telemetry capabilities. U.S. NOAA proposed to establish a SEAFRAME station in Davao or Puerto Princesa, but we recommended a site facing the Pacific Ocean to support also the TWS in the Pacific. We also recommended to the IOC to establish a SEAFRAME station in Legaspi.

National Report of the Republic of Korea

Introduction

Since the last ITSU Session in 1991, there was one tsunami affecting this country (Hokkaido Nansei-Oki Tsunami) and an associated warning was issued by the Korea Meteorological Administration (KMA).

Tsunami dummy tests, watches and warnings issued by JMA, PTWC and ATWC made the KMA review the present tsunami preparedness and improve operational procedures.

The implemented tsunami-related work includes: (1) installation of a new seismic station; (2) a meeting with the local disaster prevention authorities; and (3) revision of tsunami preparedness regulations.

Seismological Network

The KMA has been running the Automated Seismological Observation System (ASOS) and a seismic network. The ASOS has the capability to receive seismic signals from 11 remote sites in real-time, to record them on paper/drums, and analyze them both automatically and manually.

One of the 11 sites was newly installed inland at the end of 1992. In 1993, there is a plan to establish an additional one at the small island of Ulleung-do. This island site, located in the off-sea region of the East Sea of Japan will give the opportunity to detect events at the major tsunamigenic earthquake zone - the western coast of Japan.

Tsunami Information Communication

The communication of KMA with JMA, PTWC, ATWC and other foreign centers is carried out through the World Meteorological Organization's (WMO) Global Telecommunications System.

When the distant big event is recorded, the KMA sends TSUNAMI-X messages to inform the P-arrival time at Seoul and to ask earthquake parameters with tsunami information.

In 1992, KMA sent the said messages 24 times to JMA and received information including warning messages 15 times from JMA, 3 from PTWC, 2 from Khabarovsk and 1 from ATWC. Up to June this year, there were 19 inquiries from KMA, 8 messages from JMA, 4 from PTWC and 1 from Khabarovsk.

Activities for Tsunami Preparedness

The tsunami attention of February 7, 1993, issued by JMA made the Republic of Korea review the present situation of disaster prevention and improve the operational procedures for issuing tsunami warnings. Accordingly, there was a meeting with the local authorities of the region which were effected by the 1983 East Sea (Japan Sea) Tsunami, such as the local government, marine police, harbour authorities, fishery radio station and TV companies. At this meeting it was emphasized that it is very difficult to have (a warning) one hour prior to the tsunami arrival even in cases when an earthquake occurred at the farthest tsunami-prone area near Japan. Rapid action is an indispensable condition for tsunami preparedness. Taking the 1983 Japan Sea Tsunami as a case study, the participants were instructed on the cause and characteristics of tsunamis, strategy for tsunami preparedness and safety rules.

Problems and Proposals

Up to the present, the first step for a tsunami warning is interpretation of seismograms to find out the epicenter, depth and magnitude, but it is still problematic for a small span network to fix the location of distant earthquakes. For the KMA seismological network, the maximum span is about 400 km and so there may be considerable error locating events at major tsunami-prone areas which are 700-900 km away from the network. In order to solve this problem, the software has been modified. However, even after that, a reliable solution to the problem has not yet been found.

While the KMA appreciates the efforts of the Tsunami Warning Centers, especially JMA, it would be most desirable to have the International Regional Tsunami Warning Center - Far East Tsunami Warning Center (FETWC) be established, possibly coordinated through the JMA. The FETWC shall take the responsibility for tsunami warnings for the coastal regions of the Japan and China Seas, and in such a way, facilitate ITSU activities in the region and enrich the contribution to IDNDR.

National Report of United Kingdom, Hong Kong

A TWS is operated by the Royal Observatory (RO) in Hong Kong. The system comprises a seismograph network of long-period and short-period seismometers, a tide gauge network, and a communication system linking RO with the PTWC on the one hand, and the Hong Kong Government's Information Services Department (ISD) on the other. Detailed operational procedures have been set up whereby warnings will be issued to the public via ISD whenever a tsunami is expected to affect Hong Kong.

A computer program has been used since 1988 through which a time series of sea level data (up to seven days for 1-minute data and 45 days for hourly data) can be retrieved and displayed for instant inspection.

The most recent tsunami event in Hong Kong occurred on June 24, 1988. It originated from a submarine earthquake off the coast of northern Luzon which generated minor wave disturbances in Hong Kong. This event has been added to our consolidated list of tsunamigenic events in the northern part of the South China Sea that have occurred since the seventeenth century.

National Report of the U.S.A.

Introduction

In the United States, the Pacific TWS is operated by the NOAA, National Weather Service (NWS). Another component of NOAA, the National Ocean Service (NOS), is primarily responsible for the maintenance of many U.S. tide gauges in the TWS. Tsunami research is conducted by NOAA's Environmental Research Laboratories and by various universities under the direction of the National Science Foundation. The World Data Center-A (Tsunamis) is operated by NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) which also supports the TWS by providing communications from remote data platforms through NOAA's Geostationary Operational Environmental Satellite (GOES). (The Japan Meteorological Agency also provides support to the TWS by the use of its geostationary satellite to transmit data from U.S. tidal stations). The U.S. Geological Survey is responsible for seismological research and assists the TWS through the provision of real-time seismic data and in instrument maintenance and development.

General

The U.S. has continued to operate two major Tsunami Warning Centers since the Thirteenth Session of the ICG/ITSU in September 1991. These Centers, the PTWC in Ewa Beach, Hawaii, and the ATWC in Palmer, Alaska, have access to large arrays of seismic and tide stations, either directly via telemetry from remote locations or indirectly via messages from local observers.

The more significant developments that have occurred during the period since the Thirteenth Session include: significant improvements in automatic processing of seismic information at both ATWC and PTWC, expansion of the Pacific Satellite Sea Level Network, and interconnection of the PTWC and the U.S. National Earthquake Information Center computers. Work has also begun on the preparation of the 12th edition of the Communications Plan for the TWS.

The NOS has been working for a number of years on the Next Generation Water Level Measurement System which is replacing current tide gauges in the U.S. National Water Level Observation Network and at selected international locations. This tide gauge has been described in a previous U.S. National Report. These units are now being routinely installed in the Pacific Basin, with their data being accessible to the ATWC and the PTWC to support the TWS.

The U.S., in Honolulu during January 1993, hosted the second meeting of the Working Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange and the meeting of ICG/ITSU Officers.

Because of personnel constraints at the ITIC, there was no training done under the IOC/ITIC Visiting Experts Program. It is expected, depending upon the availability of funds, that training under this Program will resume in 1994.

Activity under the USA/USSR environmental bilateral exchange continued at a very low rate. Dr. Viacheslav Gusiakov, of the Novosibirsk Computing Center, visited both Centers in June 1993, and met with the Director, Pacific Region (Chairman, ICG/ITSU) to discuss continuing developments at Novosibirsk and proposed presentations at the ITSU-XIV.

Tsunami Education and Awareness Programs, A Progress Report

The international tsunami community has long recognized the importance of public education and awareness programs in mitigating the impact of tsunamis. During ITSU-XIII, the ad hoc Working Group for Public Education and Awareness acknowledged the recommendations of the assembly (specifically) recommending the development of education programs for primary and high schools. A number of activities occurring during the last two years have brought together the important issues which have resulted in the first of a series of tsunami educational materials for the children of the Pacific Basin.

At ITSU-XIV, the Member States agreed that the high-quality publication of the educational materials (as books) in various languages would be a valuable contribution to national disaster prevention programs.

Taking the lead in developing educational materials, the representatives from Chile provided a series of children's textbooks and teacher's guidebooks that provide a solid framework for learning about tsunamis and their impact. It is hoped that funding will be secured to allow for printing of the materials in Spanish by the end of 1993. Mr. H. Gorziglia, Chile, ICG/ITSU Chairman, will continue to chair the ad hoc Working Group for Public Education and Awareness. The

primary goal of the educational program will continue to foster a basic understanding of tsunamis and the need for evacuation planning to mitigate the destructive impact of this natural hazard.

As part of the education and awareness effort, ITIC developed a children's booklet (in full color) that provides an exciting introduction to the tsunami hazard that helps children understand the danger and how to escape the impending disaster. This booklet provides guidance to any country that wants to build on this effort with as little or as much modification to adapt to the local culture. For example, the educational materials are receiving limited evaluation in the Oahu (Laie, Hawaii) public school system and the home schooling program in Honolulu. Dr. Dan Walker, University of Hawaii, is assisting in the public school system introduction while Colette Oshiro has assisted in the home schooling program.

The ITIC Newsletter would be pleased to report on similar experiences in other countries; please address your responses to the Director, ITIC.

Ad Hoc Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange Evolves into a Task Team

The Ad Hoc Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange has been redirected at the Fourteenth Session of ITSU as a Task Team to work toward implementing Phase 3 of the Project Strategy Plan during the 1993-1995 intersessional period of the ICG/ITSU.

The Group of Experts met twice during the previous intersessional period and prepared a summary report for the Seventeenth Session of the IOC Assembly early in 1993. The summary report was reexamined at ITSU-XIV and considerable changes were made to the Review of the Mandate and Terms of Reference of the Group and to the recommendations of the Project Strategy Plan.

The modified terms of reference are to: 1) meet as a Task Team at regular sessions of the ICG/ITSU and otherwise conduct its business through correspondence during intersessional periods; 2) review on a continuing basis both the Project on Pacific Rapid Response System and its Strategy Plan for Phase III Implementation to evaluate progress and needs for improvements; 3) assume responsibility, in consultation with the Chairman, ICG/ITSU and the Secretary, IOC, for technical visits as specified under Phase III of the Strategy Plan; and 4) report on their activities at regular sessions of the ICG/ITSU.

The revised recommendations for the Project Strategy Plan are; 1) that every effort necessary be taken by the IOC to support the establishment of a wide-area informational exchange network among the ICG/ITSU Member States for the purpose of providing immediate access to most recently processed earthquake and tsunami data and ultimately to event waveform data using a worldwide telecommunications system such as Internet, 2) that the IOC Assembly consider ways of support for the installation of PC-based earthquake detection and location systems and making a system similar to the T.R.E.M.O.R.S. systems available throughout the Pacific, 3) and that IOC Member States make real-time seismic and tsunami data such as P arrivals, amplitudes, seismic moment, etc., collected by nuclear treaty monitoring facilities available for international exchange as needed.

An initial effort of the Task Team will be to conduct a survey of the ICG/ITSU Member States to determine their accessibility to communication systems such as Internet, their capabilities as far as automation of data acquisition and processing are concerned, and their needs for real time or near real time information outside of the requirements of the TWS of the Pacific. This survey will be prepared by the Task Team and sent out to the Member States early in 1994.

Master Plan for the Tsunami Warning System in the Pacific

In response to recommendations at ICG/ITSU-XIII (Ensenada, Mexico 1991), a lengthy discussion took place at ICG/ITSU-XIV regarding accomplishments and implementation of the provisions of the ITSU Master Plan, Chapter 6. The Group noted that much progress had been made in technology development, scientific research and communications techniques since the Plan was first published in 1987.

Even with these technological advancements, the Plan continues to provide a solid framework for operation and improvement of the TWS in the Pacific and is sufficiently flexible to have value while allowing room for advancements in technology. The Plan requires some update and modification. The Acting Director, ITIC, will chair a Task Group comprised of France and Mexico to assist in the effort to complete an addendum to the Master Plan for discussion at ITSU-XV.

Standardized Tsunami Survey Procedures

At the Fourteenth Session of ICG/ITSU, the Session recognized the need to develop standards for tsunami survey measurements of runup and damage. Recent tsunami activity over the last two years has precipitated a number of field surveys by researchers from around the world.

While many of the post-disaster tsunami surveys have been conducted using standardized procedures and have produced important findings for the scientific community, the requirement to firmly establish procedures, specifications and equipment requirements will further enhance the quality of field survey effort data.

ITIC will take a lead role, along with assistance from the representatives of Mexico and Canada, in chairing an ad hoc Working Group to develop standardized post-disaster tsunami survey procedures. Of course, input from Member and non-Member States, the scientific community, and other interested parties are solicited as we move ahead with this effort. Please address your comments to the Acting Director, ITIC.

The ad hoc group will be investigating:

- The latest in Global Positioning System (GPS) survey equipment with reported accuracy of less than 10 cm.
- Standard measurement questionnaire to maintain standards and transfer technology to ensure survey teams use the same set of parameters
- Standard questionnaire/report to confirm eye-witness accounts
- Basic photographic techniques of tsunami runup and damage
- Establishing tsunami survey teams and survey equipment "caches" along with access to national - contacts for quick field-team response to post-disaster surveys*

* *Maintaining an up-to-date list of ICG/ITSU National Contacts (particulary telephone and fax numbers as well as E-mail addresses) is required to assist in arranging clearances for field-teams to survey the post-disaster impacted areas. All National Contacts should verify the accuracy of this information in the "List of National Contacts for ICG/ITSU" beginning on page 8. Report any discrepancies, corrections and/or additions to the Director, ITIC.*

Fifteenth Session of ICG/ITSU

France has offered to host ICG/ITSU-XV in the Fall of 1995, in Papeete (Tahiti), French Polynesia.

ITIC

ITIC Visiting Experts Programme for 1994

In order to improve the International TWS in the Pacific, a Visiting Experts Programme, sponsored by the IOC and administered through its ITIC, is available to scientists and experts of IOC Member States working in the field of Tsunamis.

The 1994 programme will include training in such fields as:

- TWS operations (seismic and tsunami data acquisition; data evaluation; information dissemination; communication networks)
- PTWC instrumentation
- Applied Research and Numerical Modeling (including ITSU projects oriented to meet IDNDR objectives)

The IOC is planning to support the training of two experts in October-November 1994. The intended length of the training course is four weeks. The selection will be made jointly by the Acting Director of ITIC and the Secretary IOC.

Participants will be required to have sufficient technical and geophysical background and experience to understand the details of both instrumentation and data analysis and modeling. They should preferably be directly responsible for tidal/seismic measurements or for supervising a national TWS and have a good command of English, which will be the working language of the training course. Preference will be given to nominees from those countries which already participate actively or intend to participate in the TWS in the Pacific.

Nominations of qualified persons and their Curriculum Vitae should be sent to the IOC Secretary, with copies to the Acting Director of ITIC. The closing data for submission of nominations is July 1, 1994.

Associate Director, ITIC

At ITSU-XIV, representatives from the Member States expressed interest in knowing more about the Associate Director position at ITIC that has been vacant for the last 10 years. This expression of interest is very encouraging as the Group considered an ambitious work plan for ITIC that includes a close working relationship with the ICG/ITSU Member States. In the past, the Associate Director's salary (including personal and household goods transportation to/from Honolulu) was funded by the supporting Member State that seconded the individual to the position.

To encourage nomination of an Associate Director, it is hoped that limited financial support to augment the Associate Director's living expenses in Honolulu during the (nominal) one-year assignment will be secured by IOC/ITIC. The United States will continue to provide basic support services for the Associate Director, including office space, local services and limited secretarial assistance at the ITIC office. The posting of the Associate Director will become specially important if the ICG/ITSU is successful in moving ahead with the proposed Regional Tsunami Warning System in the Southwest Pacific. Nominations for the post should be sent directly to Dr. Y. Oliounine, Head, Ocean Services Unit, IOC.

Visitors to ITIC, July through November 1993

Professor Jean-Jacques Wagner at the Centre d'Etude des Risques Geologiques, University of Geneve (Switzerland), visited with the ITIC's Acting Director, Dennis Sigrist, on August 16, 1993. Professor Wagner also visited with Michael Blackford, Geophysicist in Charge, at PTWC and received a tour of the operations center.

In his association with the Swiss Disaster Relief Unit, Professor Wagner is involved with evaluating natural disasters for the purpose of developing mitigation strategies. He recently visited Nicaragua to study the disastrous tsunami of 1992 and will be traveling to the Philippines later this year to study the recovery efforts following the Mt. Pinatubo eruption.

Mr. Claudio Gutierrez Huete, Director General, from Managua, Nicaragua and Cmdr. Gustave Otarola Bawden and his lovely wife Patricia, from Chucuito-Callao, Peru, visited ITIC and were given a tour of the operations and functions of the PTWC in September 1993.

Dr. Fred Camfield, President of the Tsunami Society, stopped by ITIC on September 7, 1993, travelling back to the United States from Asia. Dr. Camfield is associated with the US Army Corps of Engineers, Waterways Experiment Station, in Vicksburg, Mississippi.

Mr. Sydney Wigen and his lovely wife Nancy visited ITIC on November 26, 1993, in conjunction with a personal visit to Hawaii. As some of our readers might recall, Mr. Wigen served as ITIC's first Associate Director during a two-year period beginning in 1975. The Wigen's continue to reside in British Columbia, Canada. Syd and Nancy also visited the operations center at PTWC.

ITIC on E-mail

For users desiring to contact ITIC on E-mail, the following addresses can be used:

INTERNET: itic@nalu.tsunami.soest.hawaii.edu
(ITIC is on the Tsunami Bulletin Board, so any messages posted in that manner are already received at ITIC)
OMNET: D.SIGRIST

ITIC Newlstter - Mailing List Update Requested

All our readers who receive the ITIC Newsletter via the mail are kindly requested to verify the accuracy of their mailing address. Having the correct address ensures prompt delivery of the Newsletter and keeps postage costs to a minimum. Please advise ITIC (mail, fax or E-mail) if your address requires updating. The next issue of the ITIC Newsletter is scheduled for July 1994, and we would like to have our mailing list up-to-date by May 1, 1994. Please send your changes to ITIC as soon as possible.

ICG/ITSU-XIV Action Items

A number of Action Items relating to the Implementation of Decisions and Recommendations of the Fourteenth Session of the ICG/ITSU were identified and assigned to ITIC. The following is the progress made by ITIC on these Action Items:

1. Condensed texts of National Reports submitted at ICG/ITSU-XIV are included in this Newsletter.

2. Field reports and survey results along with diagrams and photographs of areas affected by the Hokkaido Nansei-Oki earthquake/tsunami are included in this Newsletter.

3. ITIC has been assigned the lead role, along with assistance from the representatives of Mexico and Canada, in chairing an ad hoc Working Group to develop standardized post-disaster tsunami survey procedures. See related article.

4. ITIC has been assigned a lead role in updating the Master Plan for the TWS in the Pacific. Chairing an ad hoc Task Group comprised of representatives from France and Mexico, an addendum of additions and corrections will be developed for distribution amongst the Member States for comment and review. See related article.

5. The updated list of ICG/ITSU National Contacts is included in this Newsletter. Please report any discrepancies to the Director.

6. Propose plan for development of inundation maps and emergency plans for countries with limited technical capabilities. An internal, US National Workshop on Tsunami Modeling was conducted in Honolulu during November 1993 (see related article). Results from this workshop will be reviewed for applicability to this action item.

7. The Acting Director is investigating the costs associated with publishing the Chilean-developed earthquake and tsunami textbooks and guidebooks in English. It is hoped the complete series of books can be ready in time for the World Conference on Natural Disaster Reduction by May 1994. See related articles.

8. Member States are encouraged to provide ITIC with national tsunami television and radio spot announcements for review and distribution to other Member States for their review and possible application.

9. The Visiting Experts Program has been announced in this Newsletter and by individual correspondence to Member States. See related article.

10. The IOC/ITIC developed, full-color children's booklet, Tsunami Warning!, was enthusiastically received at ICG/ITSU-XIV. ITIC is anxious to work with Member States to adapt the booklet for their use. Please contact ITIC directly for additional information and procedures.

11. The existing tsunami database format is largely developed but requires conversion to contemporary database application software standards. ITIC is seeking funds to complete this task and make the format available to users upon request.

INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION (IDNDR)

IDNDR Update

The IDNDR was launched by a United Nations General Assembly resolution, adopted in 1989, with the objective of reducing through concentrated international action, especially in developing countries, the loss of life, property damage and economic and social disruption by natural disasters. The World Conference on Natural Disaster Reduction (see Announcements) in Yokohama, Japan, will provide countries an opportunity to report on their IDNDR-related activities, in particular, their efforts to achieve agreed targets for the Decade, and plans for the second half of the Decade to fully achieve the targets. By the year 2000 all countries, reflecting their target goals for the IDNDR, should have in place:

1. Comprehensive national assessments of risks from natural hazards, with these assessments taken into account in development plans.
2. Mitigation plans at national and/or local levels, involving long-term prevention and preparedness and community awareness.
3. Ready access to global, regional, national and local warning systems and broad dissemination of warnings.

The ICG/ITSU Member States have been called upon to contribute to the World Conference. This Conference, in particular, gives a unique opportunity to make different groups of society acquainted with the IOC and other international agency activities in the field of tsunami research, mitigation and preparedness in direct support of the IDNDR.

National and Area Reports

Dr. Jacques Talandier, Laboratoire de Geophysique (LDG) at Tahiti, Retires

Francois Schindele Selected as Head, LDG

Jacques Talandier has retired from his position as Head of the Laboratoire de Geophysique (LDG) at Tahiti, Centre Polynesian de Prevention des Tsunamis. Dr. Talandier, together with Emile Okal, is recognized for his many contributions to the field of seismology and, in particular, rapid determination of seismic moment.

Dr. Talandier's association with the LDG and the international (ICG/ITSU) tsunami community has spanned more than 30 years. Jacques arrived in Tahiti in 1961, where he was assigned to study acoustic wave propagation in the atmosphere. But at that time there was no laboratory, and Jacques, under the advice of Professor Rocard (Ecole Normal Superieure de Paris) soon shifted from acoustics to develop and install seismic stations in Tahiti and Rangiroa.

That marked the beginning of the geophysical laboratory in Tahiti. In 1971 he defended his PhD thesis at the University of Paris on T-wave propagation in the ocean. He first thought that T-waves would be a very good indicator of tsunamigenic earthquakes. But, after studying records of the great 1960 Chilean earthquake and subsequent tsunami, he formulated the idea that long period seismic waves would be a better indicator and that seismic moment could be retrieved accurately and rapidly from long period data. With long period seismic instrumentation developed by the LDG, he started to develop the concept of mantle magnitude (M_M). In 1980 this concept was further developed with the help of Professor Emile Okal, Dominique Reymond and Olivier Hyvernaud.

Jacques is enjoying his retirement and spending time doing what he loves most (apart from seismology!); mountain climbing in the Pyrenees. Let us all wish Jacques Talandier a long, healthy retirement, thanking him for his active participation and many contributions in the field of seismology and tsunami research.

Francois Schindele assumed the position of Head of the LDG, Tahiti, in July 1993, replacing the retiring Jacques Talandier. The international tsunami community looks forward to continuing the fine relationship with Francois Schindele and the staff at the LDG, Tahiti.

Actions Taken by Nicaragua to Mitigate the Effects of Future Tsunamis

Mr. C. Gutierrez Huete, Instituto Nicaraguense de Estudios Territoriales at ITSU-XIV; Tokyo, JAPAN, September 1, 1993

Overview and Introduction

The author presented a summary report and a review of mitigating actions taken by Nicaragua following the locally damaging tsunami of September 1, 1992.

The Pacific Coast of Nicaragua experienced the effects of a tsunami on September 1, 1992, at 19:15 local time. The earthquake generated waves with an average height of 4.6 meters and a maximum height of 9.9 meters recorded at the resort of "El Transito," located in the middle area of the Pacific coast of Nicaragua.

Given that it had never experienced any type of disaster like this, the coastal population ignored the seismic occurrence, mainly because of its almost imperceptible intensity. Nevertheless, the earthquake generated large waves that reached the Pacific coast in approximately 45 minutes, creating a serious impact on the coastal population. According to official reports from Nicaragua Civil Defense, the loss of human lives was listed at 105, with 63 missing, 489 injured, and more then 13,000 people left without living accommodations. In 23 population centers, 773 houses were destroyed.

Actions taken to mitigate the effects of future tsunamis include a systematic plan to relocate people from areas where

dwellings were destroyed by the tsunami to higher ground. By setting the residences on higher ground and at a greater distance from the ocean, a buffer strip is established to provide protection against tsunami impact.

Report on The Flores Earthquake - Tsunami of December 12, 1992

Mr. Sunarjo, Meteorological and Geophysical Agencies, Indonesia, at ITSU-XIV; Tokyo, JAPAN, September 1, 1993

Overview

The author presented a summary report of this devastating earthquake and tsunami that inflicted heavy casualty and property losses in Indonesia. Included in the report is a review of the Indonesian seismological and tide gauge networks, a description of the Coordination Board for Disaster Mitigation, distribution of tsunami height, tectonic uplift and subsidence, and a graphic overview of areas attacked by tsunami. The effects of the earthquake and resulting tsunami included 1,974 killed, another 2,126 injured, and over 3,000 buildings and residences either totally destroyed or damaged. Numerous bridges and roadways were either destroyed or heavily damaged. The Indonesian government mobilized a very great response towards the disaster of the Flores earthquake-tsunami in order to mitigate its impacts. Response of the effected communities was great as well as support from international communities and organizations.

Tsunami Inundation Modeling Workshop, Honolulu, Hawaii

The National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory organized a tsunami modeling workshop as part of its efforts to establish an improved tsunami hazard reduction program. The Workshop was held at the University of Hawaii in Honolulu, Hawaii, on November 16 - 18, 1993. Twenty-one people participated in the workshop, including nine emergency specialists. The goals of the modeling program are to, 1) develop model-based tsunami inundation maps for at-risk communities, 2) improve the tsunami detection/warning system, and 3) conduct research to improve tsunami modeling and data collection. The Workshop specifically represented the (tsunami hazard) interests of Alaska, California, Hawaii, Oregon and Washington states. The Acting Director, ITIC, participated in the Workshop.

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Report on Sixteenth International Tsunami Symposium, E. N. Bernard

From August 23 to 25, 1993, the 16th IUGG International Tsunami Symposium was held in Wakayama, Japan, in conjunction with the ICG/ITSU of the IOC. This joint Symposium was organized by the Japan Society of Civil Engineers under the talented leadership of Yoshito Tsuchiya of Kyoto University and Nobuo Shuto of Tohoku University. By any measure, the Symposium was a tremendous success. The scientific program was outstanding because the organizing committee had (1) screened over 100 proposed presentations to 76 quality presentations, (2) required that each presentation be written as a contribution to the Proceedings before the Symposium, and (3) distributed the Proceedings at the meeting so all attendees could read along with the presentation.

Included with this article is the Table of Contents of the Proceedings, which gives the titles and authors of the papers. Six papers were not presented - numbers 32, 57, 70, 71, 72, and 73 in the attached list. One presentation on the July 12, 1993, Hokkaido Tsunami by N. Shuto had no written report because of the lack of time to include it in the Proceedings. The scientific quality of the presentations was high, and the reports on the three most recent tsunamis in Nicaragua, Indonesia, and Japan maintained audience attention. An icebreaker, a reception by the Governor of Wakayama Prefecture, and a closing banquet satisfied the participants' social needs.

In summary, Tsunami '93 was a perfect blend of quality science and Japanese hospitality making for an unforgettable experience for all participants.

Sixteenth International Tsunami Symposium Opening Address

(Dr. E. N. Bernard, Chairman, Tsunami Commission, August 1993. Abridged for ITIC Newsletter)

On behalf of the Tsunami Commission, I have the great privilege of opening the International Tsunami of the International Union of Geodesy and Geophysics (IUGG) here in Wakayama, Japan. It is my great honor to extend to all of you a very cordial welcome to this Symposium. First of all, as the Chairman of the Tsunami Commission, I wish to express my heartfelt gratitude to the Executive Committee for the organization of International Tsunami Symposium 1993 and, in particular, to Yoshito Tsuchiya and Nobuo Shuto, who led the committee in its untiring efforts in hosting this Symposium.

The IUGG was created in 1960 in Helsinki, Finland, at the 12th General Assembly to promote the exchange of scientific and technical information about tsunamis among nations concerned with the tsunami hazard. Since its beginning, the Commission has sponsored 16 tsunami symposia and has encouraged the publication of 12 proceedings containing over 350 research reports from these symposia. Since 1960, tsunami symposia have been held throughout the world.

Particularly noteworthy is the 31-year record of publishing research from the symposia. From the past two, books have been published on selected papers. And, thanks to Professor Tsuchiya and Shuto, we have the proceedings of the 1993 Symposium in hand.

In 1989, at the Novosibirsk Symposium, the Commission took a bold step to go beyond the reporting of tsunami research. We embraced the International Decade of Natural Disaster Reduction (IDNDR) as an opportunity to contribute to the mitigation of the effects of tsunamis throughout the globe by identifying a single need. That single focus was "an internationally accepted method for preparing tsunami flooding maps." We realized that such an effort would require international cooperation to collect appropriate data and to construct models that could realistically simulate tsunami dynamics. Today, we gather once again as a global community to share information and ideas on filling this need.

Before we begin our discussions, however, I would like to give you a brief report on our progress over the past 4 years. Our goal of developing methods for estimating tsunami flooding requires good models to simulate the behavior of the tsunami and observations to verify that these models are sufficiently accurate to be used for emergency preparedness planning.

Since 1989, there have been four tsunamis - three of which were major disasters. In 1992, the tsunami in Nicaragua killed over 140 people, and on Flores Island in Indonesia, the tsunami killed about 1,000 people. In 1993, the Hokkaido Nansei-Oki tsunami took about 120 lives.

These disastrous tsunamis were surveyed by scientists from Japan, the United States, Canada, Nicaragua, and Indonesia to collect precious measurements on the extent of tsunami flooding. All scientists generously made their data available to each other and to modelers, who conducted experiments with new information. Over the next three days, you will hear detailed reports on the surveys and experiments using these new data. I would like to recognize the unselfish generosity of each scientist who shared these data. As I observed this process of sharing unfolding on the electronic mail system, I realized that this was a special group of scientists who were more interested in advancing their field than they were in advancing themselves as individuals. I applaud your high moral values.

In addition to new data, we also need a focused modeling effort to convert research into useful information. In this regard, the Tsunami Commission joined with the IOC to financially support a tsunami project during the IDNDR. The project - Tsunami Inundation Modeling Exchange (TIME) -, is a modeling center at Tohoku University under the direction of Nobuo Shuto that trains scientists from foreign countries in the use of numerical models to estimate the extent of tsunami flooding. We are optimistic that funding will be available this year to support the Center. While awaiting word on funding, Professor Shuto has proceeded to make TIME happen. He has already exported his model to the United States, Turkey, Korea, and Mexico. We should all be inspired by this generous scientist who, in spite of uncertainty, proceeded to share his technology with those in need.

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In closing, I am very proud to have been part of these exciting times. We are well along the path of fulfilling the need for tsunami flooding estimates. This community has a sense of purpose, a plan, and a commitment to the cause of reducing the horrible effects of tsunamis. Keep up the fine work and don't quit until we are through. Thank you!

Tsunami '93 Proceedings - Papers as Listed in the Table of Contents

1. Tsunami Generation, Propagation and Seismic Focus

1) Koutitas, C. and M. Gousidou-Koutita: A Nonlinear Dispersive Wave Model for Tsunami Generation and Propagation in Coastal Water

2) Shuto, N. , K. Chida and F. Imamura: Generation Mechanism of the 1983 Nihonkai-Chubu Earthquake Tsunami

3) Carrier G.F.: On-shelf Tsunami Generation and Coastal Propagation

4) Ivanov, V.V.: Evolution of Earthquake Processes

5) Henry, G.F. and T.S. Murty: Tsunami Simplification Due to Resonance in Alberni Inlet: Normal Modes

6) Yalciner, A.C., U. Kuran, A. Akyarli and F. Imamura: An investigation on the Propagation of Tsunamis in the Aegean Sea by Mathematical Modeling

7) Yeh, H.: The Leading Wave of a Uniform Bore

8) Go, C.N.: The Limitation of Tsunami Wave Height

9) Rabinovich, A.B., V. A. Djumagaliev, I.V. Fine and E.A. Kulikov: Analysis of Weak Tsunamis in the Region of Kuril Islands and Resonance Influence of Topography

10) Romashko, D.N.: The Great Alaskan 1964 Earthquake and Associated Tsunami Source: Verification of Seismic Fault Model

11) Papadopoulos, G.A.: Seismic Faulting and Nonseismic Tsunami Generation in Greece

12) Satake, K.: Joint Inversion of Geodetic and Tsunami Data to Estimate Coseismic Slip Distribution: The 1944 Tonankai and 1946 Nankaido Earthquakes, Japan

13) Johnson, J.M. and K.Satake: Study of Source Processes of the 1957 Aleutian and 1938 Alaskan Earthquakes Using Tsunami Waveforms

14) Abe, Ku.: Tsunami Spectrum as a Synthesis of Source Spectrum and Shelf Response

15) Hatori, T.: Distribution of Tsunami Energy on the Circum-Pacific Zone

16) Synolakis, C.E. and S. Tadepalli: The Runup of Dipole Waves

2. Tsunami Prediction and Simulations

17) Noji, M., F. Imamura and N. Shuto: Numerical Simulation of Movement of Large Rocks Transported by Tsunamis

18) Tanioka, Y. and K. Satake: Analysis of Tsunami Waveforms from 1854 and 1946 Earthquakes Along the Nankai Trough, Japan

19) Chung, J.Y., S.D. Kim and V.V. Ivanov: Tsunami Wave Forecasting and Aposteriori Estimation in the East Sea (Japan Sea)

20) Nomanbhoy, N. and K. Satake: Numerical Computations of Tsunamis from the 1883 Krakatau Eruption

21) Rok, V.E.: Far Propagation of Hydroacoustic Precursors of Underwater Earthquake

22) Takahashi, T., F. Imamura and N. Shuto: Numerical Simulation of Topography Change due to Tsunamis

23) Liu, P., S.B. Yoon, S.N. Seo and Y. Cho: Numerical Simulation of Tsunami Inundation at Hilo, Hawaii

24) Watanabe, H.: Amplitude Coefficient of Maximum Tsunami by Traveling Distance and Tsunami Magnitude

25) Shokin, Y.I., G.S. Khakimsyanov and L.B. Chubarov: New Potentialities of Computational Experiment in Tsunami Problem

26) Uda, T., S. Tanaka and H. Ito: Experiment on Formulation and Propagation of Mach Stems at a River Mouth

27) Nakata, T. and T. Kawana: Historical and Prehistorical Large Tsunamis in the Southern Ryukyus, Japan

28) Levin, B., V. Kaistrenko, A. Kharlamov, M. Chepareva and V. Kryshny: Physical Processes in the Ocean as Indicators for Direct Tsunami Registration from Satellite

29) Mader, C.L. and E. N. Bernard: Modeling and Tsunami Flooding of Crescent City

3. Instrumentation, Observations and Tsunami Data Base

30) Kato, K., Y. Tsuji, S. Harada, K. Matsumoto and M. Koyama: Development of Tsunami Detection and Prediction Systems by Using Sea Level and Seismic Sensors for Local Municipalities

31) Sato, K. and Y. Utsumi: Sea Level Tsunami Observation System - The Case of Kesennuma

32) Gusiakov, V.K. and A.V. Osipova: Expert Tsunami Database

33) Ivanov, V.V., S.L. Lopatnikov and B. Gurevich: Proposal for Tsunami Warning with the help of the Short-Period Hydroacoustic Field from an Under- water Earthquake

34) Okada, M.: Tsunami Observation by Ocean Bottom Pressure Gauge

4. Tsunami Disasters and Mitigation

35) Chu, K.S. and Y. Tsuji: Historical Records of Earthquakes and Tsunamis in the Region of the Korean Peninsula and its Vicinity

36) Chung, J.Y., C.N. Go and V.M. Kaistrenko: Tsunami Hazard Estimation for Eastern Korean Coast

37) Okazaki, S., K. Shibata and N. Shuto: Road Disaster Prevention Against Tsunamis Along Sanriku Coast in Iwate Prefecture

38) Nakamura, S. and S. Habara: Historical Tsunamis in Relation to Public Works in Wakayama

39) Hata, H., M. Yamamoto, A. Nakayama, T. Takeuchi and J. Yamamoto: Hydraulic Phenomena and Tsunami Damages in Fishing Ports - A Case Study of the Nihonkai-Chubu Earthquake Tsunami

40) Bernard, E.N., F.I. Gonzalez and K. Satake: The Cape Mendocino Tsunami, April 25, 1992

41) Murakami, H., T. Shimada, S. Itoh and Y. Hiraiwa: Reexamination of Historical Tsunami Data of Shikoku Island

in Japan

42) Kawaguchi, T., H. Takeuchi and S. Itoh: New Tsunami Countermeasures that take into Consideration the Development of the Living Environment and Coastal Landscape

43) Abe, Ka.: Estimate of Tsunami Heights from Earthquake Magnitudes

44) Matsutomi, H. and H. Ikeda: A Study on Impulsive Force of Drifting Timber Under Consideration of Shock Absorption Function of Water

45) Maramai, A. and A. Tertulliani: Minor Tsunamigenic Events in Italy: A Critical Revision

46) Kawata, Y., S. Tamai and Y. Matsuda: Comparative Study on Tsunami Disasters in Kochi and Sanriku Coasts

47) Ma, K.F., K. Satake and H. Kanamori: Tsunami Excited by the 1975 Kalapana, Hawaii Earthquake

48) Lander, J.F.: Alaskan Tsunamis Revisited

49) Nishimura, Y. and K. Satake: Numerical Computations of Tsunamis from the Past and Future Eruption of Komagatake Volcano, Hokkaido, Japan

50) Briggs, M.J., C.E.Synolakis and S.A. Hughes: Laboratory Measurements of Tsunami Runup

51) Sakai, S., N. Oshima, K.Kumagai and H. Toyama: Special Problems in Development of Fishing Communities in High Tsunami Risk Regions

52) Kanamori, H. and M. Kikuchi: Mechanism of the 1992 Nicaragua Tsunami Earthquake

53) Titov, V.V. and C.E. Synolakis: A Numerical Study of Wave Runup of the September 2, 1992, Nicaraguan Tsunami

54) Ide, S.H. Imamura, Y. Yoshida and Ka. Abe: Source Mechanism of the Nicaraguan Tsunami Earthquake of September 2, 1992

55) Imamura, F., N. Shuto, B.H. Choi and H.J. Lee: Visualization of Nicaraguan Tsunami in September 1992

56) Tsuji, Y., H. Kato, Ku. Abe, Ka. Abe, F. Imamura and Y.Iio: Human and Building Damages of the 1992 Nicaragua Earthquake Tsunami - Damages of El Transito

57) Darace, M.: Brief Note about Nicaraguan Tsunami, September 1992

58) Kawata, Y. and Field Survey Group: Response of Residents at the Moment of Tsunami - The 1992 Flores Island Earthquake Tsunami, Indonesia

59) Shi, S., A.G. Dawson and D.E. Smith: Geomorphological Impact of the Flores Tsunami of December 12, 1992

60) Shimada, T., H. Murakami, S. Itoh and J. Ishizuka: Estimation of Inundation Heights of the 1854 Ansei Nankai Tsunami along the Shikoku Coast in Japan

61) Miyano, M., L.H. Jian and T. Mochizuki: Human Casualty Due to the Nankai Earthquake Tsunami, 1946

62) Sakai, T., Y.Tsuchiya, Y. Kawata and T. Shimada: Reproduction of the Ansei-Nankaido Tsunami in Osaka

63) Tsuji, Y. and T. Hino: Inundation Heights of the Tsunami Accompanied with the Landslide of Maruyama Hill on Shimabara Peninsula in 1792 - On the Eastern Coast of Ariake Bay

64) Togashi, H. and Y. Hirayama: Hydraulic Experiment on Reappearance of the Ariake-kai Tsunami in 1792

5. Tsunami Warning System and Plans for Improvement

65) Uchiike, H.: Japan Tsunami Warning System, Present Status and Future Plan

66) Ye, L., X. Wang and C. Bao: Tsunami in the China Seas and its Warning Service

67) Lorca, E.: The Chilean National Tsunami Warning System

68) Gonzalez, F., S. Sutisna, P. Hadi, E. Bernard and P. Winarso: Some Observations Related to the Flores Island Earthquake and Tsunami

69) Abe, Ku., Ka. Abe, Y. Tsuji, F. Imamura, H. Katao, Y. Iio, K. Satake, J. Bourgeois, E. Noguera and F. Estrada: Survey of the Nicaragua Earthquake and Tsunami of September 2, 1992

70) Metalnikov, A.P. and I.P. Kuzminikh: The Strategy and the Results of the Modernization of Tsunami Warning Service in Russia

71) Metalnikov, A.P. and I.F. Lanin: The Results of Experiments in the Tsunami Warning System in Russia

72) Basihilov, I.P. and I.F. Lanin: Automated Seismic Complex

73) Chubarov, L.B., Y.I. Shokin and A.N. Sudakov: Software and Hardware Support for Tsunami Warning Service

74) Reymond, D., O. Hyvernaud and J. Talandier: The Basis of Tsunami Warning: Fast Evaluation of Location, Focal Depth and Seismic Source Parameters

75) Kuroiwa, J.: Tsunami Studies and Their Application to Peru's Socio-Economic Development and Emergency Planning

76) Sunarjo: Experience in Handling the Flores Earthquake-Tsunami of December 12, 1992

77) Baptista, A.M., G.R. Priest and T.S. Murty: Field Data for the 1992 Nicaragua Tsunami: Synthesis and Interpretation

IUGG Tsunami Commission Meeting

The meeting was called to order by Dr. E. N. Bernard at 19:00 on Tuesday, August 22, 1993, in the Tokyu Inn at Wakayama, Japan. Fifteen Commission members were present, including E. Bernard, A. Dawson, S. Farreras, F. Gonzalez, S. Iwasaki, H. Kanamori, J. Lander, E. Lorca, T. Murty, E. Okal, K. Satake, N. Shuto, F. Stephenson, S. Tinti, and Y. Tsuji.

There were reports on the TIME project, the publication of the book "Tsunamis of the World," the tsunami bulletin board, and upcoming meetings.

N. Shuto reported that the TIME project had transferred his model to the United States, Canada, Turkey, and Korea, and a Mexican student was being trained at present. During the Symposium, scientific reports were made by scientists using TIME models. A. C. Yalciner of Turkey reported on modeling study of the Aegean Sea; P. Lau of the United States reported on a modeling study of Hilo, Hawaii; and B. H. Choi of Korea reported on model study of the Sea of Japan. All these reports used the Shuto model. E. Bernard reported that the Commission is still trying to secure funding for TIME through the IOC. Finally, M. Ortez of Mexico (present TIME student) was introduced to Commission members. He is supported by the

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Japanese International Cooperative Agency (JICA). S. Farreras reported that the JICA program is very effective, and he recommends using JICA as an alternative support for TIME students.

Professor S. Tinti of Italy showed the Commission members a copy of the latest book from the Vienna, Austria, Tsunami Symposium. He thanked Commission members for serving as reviewers of the articles published. The Commission members thanked him for a job well done. He recommended that the editor for the 1995 Boulder, Colorado, Tsunami Symposium be identified before the meeting to expedite publication of the next book. The Commission is seeking a volunteer to serve as editor of this book. Any nominations should be sent to E. Bernard by January 1, 1994.

F. Gonzalez reported on the tsunami electronic bulletin board. He showed how to access the bulletin board and how to contribute to the data file. All members agreed that this was an effective way to communicate.

The final topic was a discussion about upcoming meetings. S. Tinti will chair a session at the April meeting of European Geophysical Society (EGS) in Grenoble, France; E. Bernard will chair a session at PACON 94 in July in Townsville, Australia; and N. Shuto and E. Bernard will convene the next IUGG Tsunami Symposium in Boulder, Colorado, in July 1993.

Tsunami Society Meets in Wakayama, Japan

A meeting of the Tsunami Society was held in Wakayama, Japan, on August 24, 1993. Agenda items included the election of officers, a proposal to reduce the Journal page charges for members, discussion of use of credit cards to pay membership dues, and discussion of action to formally apply for US tax-exempt status. The results of the officer election are as follows:

Dr. Fred E. Camfield, President
Prof. Stefano Tinti, Vice President
Mr. Dennis Sigrist, Secretary
Dr. Augustine Furumoto, Treasurer
Dr. George Curtis continues as a past President and Director

There was an agreement to reduce page charges in the Science of Tsunami Hazards to US$25 per page for Tsunami Society members. Page charges remain at US$50 per page for non-members. It was also noted that the Journal is soliciting new manuscripts.

Instructions were forwarded to the treasurer to proceed with action to allow use of credit cards for dues payments and to establish tax exempt status for the Society. Authority to allow use of credit cards has been established. Visa and MasterCard can now be used for payment of dues and page charges, eliminating costs associated with bank drafts for international payments. Dues remain at US$25 per year for individual members, US$100 per year for institutions, and US$5 per year for students. We have also been informed by the Journal's publisher that back copies are available for all previous issues. These are available, on a special limited-time offer, for US$10 per issue or US$150 for the full set. Orders should be placed with the Tsunami Society, P.O. Box 8523, Honolulu, Hawaii, 96815, USA. Orders should be pre-paid; credit cards are now accepted.

The December 1993 issue of the Tsunami Society Journal, Science of Tsunami Hazards, is in the mail and includes parts 2 and 3 on Tsunami Source Modeling by C. Mader and G. Curtis.

Seismological and Tsunami Hazards in the Pacific, January 10, 1994

A Workshop, "Seismological and Tsunami Hazards in the Pacific," will be conducted at the International Association of Seismology and Physics of the Earth's Interior (IASPEI) Assembly in Wellington, New Zealand, in January 1994. The workshop will be held on the first afternoon of the assembly, Monday, January 10, 1994. This workshop is being organized by Drs. Robin D. Adams and Warwick D. Smith. For further information contact the IASPEI 94 Organizing Committee at:

Fax: 64-4-471-0977
Internet: IASPEI94@m2g.gns.cri.nz

Tsunami Session, Seismological Society of America

There will be a special session on tsunamis at the annual meeting of Seismological Society of America, April 7 - 9, 1994. The meeting is in Pasadena, California, providing an excellent chance to visit Caltech or the University of Southern California (or Disneyland). All the papers are on poster format leaving more time to have in-depth discussions with other colleagues. The abstract deadline is January 18th. The Earthquake Engineering Research Institute annual meeting will follow with more earthquake engineers and policy makers anticipated to come. If you need more information, please contact Kenji Satake using INTERNET: kenji@geo.lsa.umich.edu . The following is a short description of the special session:

Tsunamis: Seismological and Engineering Aspects

In the last twelve months, earthquakes in Nicaragua, Indonesia and Japan generated large tsunamis and killed thousands of people. On the west coast of the United States, geological studies have identified evidence of past tsunamis.

This session is for discussion of various aspects of tsunamis, including but not limited to, a mechanism of "tsunami" earthquakes; paleo-tsunami data and long term seismicity; tsunami runup based on field survey, hydraulic experiment or numerical computation; mitigation of tsunami hazard for future earthquakes.

Convener: Kenji Satake
Dept. of Geological Sciences
University of Michigan
Ann Arbor, MI 48109

ANNOUNCEMENTS

European Geophysical Society (EGS) Natural Hazards and Tsunami Meeting, April 25-29, 1994

(Report provided by Dr. Stefano Tinti)

The XIX General EGS will be held next year at Grenoble, France, from April 25-29. The 1993 EGS is structured in VIII (eight) Sections, one of which is devoted to Natural Hazards (NH). During the General Assembly each section will have its own symposia. NH is organizing seven meetings on various aspects of the NH; one of these concerns tsunamis. The following is a list of the symposia:

NH1/SE8 "Analysis and Evaluation of Risk Related to Earthquakes"

Conveners: P. I. Bard (Grenoble), A. Marcellini (Milano), P. Suhadolc (Trieste)

NH2/SE9 "Seismic Hazard Assessment: Long-and Short-Term Analyses and Precursor Reliability Evaluation"

Conveners: J. L. Le Mouel (Paris), G. A. Papadopoulos (Athens), J. Zschau (Potsdam)

NH3/HS6 "Forecasting and Mitigation of Flash Flood and Mud Flow"

Conveners: M. Meunier (Grenoble), C. Obled (Grenoble), F. Siccardi (Genoa)

NH4 "Hazards Related to Snow Avalanches: Zonation, Prediction and Dynamic Evolution"

Convener: G. Brignet (Grenoble)

NH5/NP7 "Natural Hazards: Nonlinear Aspects of Generation and Evolution of Extreme Events"

Conveners: L. A. Mendes-Victor (Lisbon), S. S. Moisev (Moscow), P. C. Sabatier (Montpellier)

NH6 "Hazardous Tsunamis: Experimental Observations and Theoretical Modeling"

Conveners: S. L. Soloviev (Moscow), S. Tinti (Bologna)

NH7/SE10 "Natural Hazards Associated with Volcanic Eruptions: Physical Volcanology and Forecasting of Eruptions"

Conveners: R. Scarpa (Aquila), P. Lesage (Chanbery), J. Zlotnicki (Paris)

As you may see, the NH6 Symposium is specifically devoted to tsunamis. Deadline for receipt of abstracts is January 1, 1994. Abstracts should be mailed correctly, formatted to the EGS Office and to one of the conveners. If you are interested in receiving instructions for abstract preparation, let me know.

Addresses of the two NH6 conveners are:

Professor Stefano Tinti
Dipartimento di Fisica
Settore di Geofisica
Viale Berti Pichat, 8
40127 Bologna, Italy
Telephone: +39-51-243330
Fax: +39-51-250106

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International Symposium on Urban Disaster Reduction

Sponsored by Tianjin Municipal People's Government State Seismological Bureau of China

Tianjin Municipal People's Government, in cooperation with the State Seismological Bureau of China and China Disaster Prevention Association, will hold the International Symposium on Urban Disaster Reduction from May 22 - 25, 1994 in Tianjin, China.

The Symposium aims at providing government officials, experts, and scholars from various countries an opportunity to exchange the research results and successful experiences in urban disaster reduction. Through the exchange, we can better understand the present situations of urban disasters, their characteristics and the measures in urban disaster prevention so as to reduce all kinds of disasters threatening human beings to the minimum degree.

The Chairman is Professor Lu Huansheng, Vice Mayor of Tianjin Municipality, Hydraulician. All mail should be addressed to:

Secretariat
International Symposium on Urban Disaster Reduction
Seismological Bureau of Tianjin Municipality
No. 19 Friendship Road
Tianjin, 300201, China

World Conference on Natural Disaster Reduction, May 23-27, 1994

The World Conference on Natural Disaster Reduction, organized for the International Decade of Natural Disaster Reduction (IDNDR), is planned for May 23-27, 1994 in Yokohama, Japan. The results of the Conference will contribute to the mid-term review of the Decade in 1994 by the United Nations Economic and Social Council, as required by the General

ANNOUNCEMENTS

Assembly. The aims of the Conference are to:

- review IDNDR accomplishments at national, regional and international levels;
- chart an action programme for the future;
- exchange information on the implementation of IDNDR programmes and policies;
- and, increase awareness of the importance of the progress of disaster reduction policies.

The Representative of the IDNDR Secretariat, Mr. A. Takeda, presented an overview of the Conference at ITSU-XIV (Tokyo, Japan) and encouraged participation by the ICG/ITSU at the Conference. Ideas regarding ICG/ITSU participation at the World Conference should be sent directly to the Secretary, IOC, as soon as possible.

6th Pacific Congress on Marine Science and Technology (PACON), July 4-8, 1994

The role of marine science and technology in the economic development of the Pacific Basin resources is of vital concern to planners, policy makers, administrators, educators and scholars. PACON, the biennial Pacific Congress, brings together scholars and resource people to address key issues concerning the marine technology related to the oceanic economic potential of the region from a multidisciplinary perspective.

The Congress facilitates the exchange of views and ideas between representatives of the Pacific Island nations and of the larger rim countries and thereby strengthens future information exchange and collaboration. Interested scientists, technologists and environmental managers are invited to attend the Sixth Pacific Congress on Marine Science and Technology to be held at James Cook University of North Queensland, Townsville, Queensland, Australia, during the period of July 4-8, 1994. Drs. E. N. Bernard and Y. Tsuji will be co-chairing a session on tsunamis.

For further information, contact:

PACON 94,
Local Organizing Committee,
C/-Conference & Events Management Townsville
P.O. Box 1630
Townsville, Queensland
Australia

Third Western Pacific Geophysical Meeting in Hong Kong, July 25-29, 1994

Dr. Tsuji and Dr. Satake are organizing a special session on Tsunamis in the Western Pacific Region. These include, but not limited to, the recent tsunamis in Indonesia, Japan and the Marianas. The abstract deadline is February 3, 1994. More information can be found in EOS (November 9 issue) or available from Dr. Satake.

Special Session "Tsunamis in the Western Pacific Region"

In the western Pacific region, many seismic and non-seismic tsunamis have occurred. In the recent years alone, the 1992 Flores (Indonesia) and 1993 Hokkaido (Japan) earthquakes caused devastating tsunamis. The 1993 Guam earthquake, the largest earthquake in the Mariana region, also recorded tsunamis on tide and ocean bottom gauges. Many field, numerical and experimental studies on these tsunamis, as well as historical tsunamis, have been done.

This session provides a forum to discuss seismological, oceanographical, coastal engineering and social aspects of tsunamis in the western Pacific Region. Of related interest, other special sessions include:

O04: Marine Intertidal Environment
O07: Circulation of Asian Marginal Seas
O09: Real-time Ocean Monitoring Systems

SE02: Broad-band Seismology in the Western Pacific
SE04: Recent Large Earthquakes in the Western Pacific
SE06: Earthquake Prediction Studies

Conveners:
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Sasakawa-DHA Disaster Prevention Award

The Sasakawa-DHA Disaster Prevention Award, which carries an annual prize of approximately US$40,000, is intended to promote humanitarian activities and scientific research resulting in a significant reduction of risks, thereby helping to minimize damage and loss of life in the case of natural disasters and other emergencies. It was created at the initiative of the Japanese Philanthropist, Mr. Ryoichi Sasakawa, and is administered by the Department of Humanitarian Affairs (DHA), United Nations, Geneva (Office). Candidates for the award can be nominated using applications obtained from the DHA, Palais des Nations, CH-1211 Geneve 10 SWITZERLAND, or by writing ITIC.

The award gives recognition to work done in particular in developing countries and seeks to stimulate a wider range of activities of this kind. This is an excellent opportunity for the tsunami community to recognize either individual or institutional efforts to expand disaster prevention activities. Nominations should reach DHA-Geneva before the end of January 1994.

ANNOUNCEMENTS

Just Published

TSUNAMIS IN THE WORLD

Fifteenth International Tsunami Symposium, 1991, by Professor Stefano Tinti, Department of Physics, University of Bologna, Italy

Tsunamis in the World opens an interesting window on the present-day research on tsunamis. It is a selection of 16 contributions out of the 39 presentations given at the XV International Tsunami Symposium (Vienna, August 1991). These papers, rigorously scrutinized by an international board of referees, cover the most prominent aspects of current tsunami research, including experimental observations and theoretical, analytical and numerical modeling of the basic phenomena, such as tsunami generation, open-ocean wave propagation, and waves impacting and inundating the coasts. The important social issues of coastal protection and hazard reduction are also dealt within specific articles.

Tsunamis in the World is suitable to all involved in tsunami research as well as to a more general public. It is useful for authorities responsible for social security and natural hazard mitigation plans, geophysicists, oceanologists, earth scientists, and even students who wish to study and understand tsunamis.

This 1993 Hardbound book , #ISBN 0-7923-2316-5, consisting of 236 pages, can be purchased for US$82.50.

Pacific-Wide Tsunamis Reported In Hawaii From 1819 Through 1990: Runups, Magnitudes, Moments, and Implications For Warning Systems.

A Technical Report to the Pacific Tsunami Warning Center, Walker, D. A. , March 1993.

Abstract

The recent compilation of a worldwide catalog for large, shallow earthquakes from 1900 through 1989 with uniformly determined surface wave magnitudes (M_S) and seismic moments (M_O) permits the evaluation of the efficiency and reliability of tsunami warning systems employing various M_S and M_O criteria. To complement the earthquake data and to provide the basis for a comprehensive evaluation, an updated catalog of Pacific-wide tsunamis in Hawaii is used. These data reveal that large Pacific-wide tsunamis continue to originate primarily in four regions: South America, the Alaska-Aleutian Islands region, Kamchatka, and the Kuril Islands-Northern Japan region.

In addition to the 1946 Aleutian Islands "tsunami earthquake," two other earthquakes along the margins of the North Pacific are found to have extremely low values for M_S and M_O relative to their reported runups. The M_S and M_O, and runup data indicate that reliable and timely values for M_S and M_O have been available throughout the 20th century, combined criteria of $M_S \geq 8.0$ or $M_O \geq 10 \times 10^{20}$ Nm for the whole Pacific would have resulted in an average of only 4.6 warnings every 10 years with 1.3 associated with runups ≥ 1.0 m and 1.0 associated with runups < 1.0 m but ≥ 0.3 m. With these criteria only one tsunami with a runup ≥ 1.0 m (i.e., 1.2 m from a Vanuatu earthquake in 1901) would have been missed from 1900 through 1989. However, the closeness of the 10×10^{20} Nm criteria to the 11.0×10^{20} Nm value for the catastrophic 1946 earthquake indicates that such criteria entails substantial risks of not issuing warnings for similar "tsunami earthquakes" with slightly lower values for M_O. Furthermore, the lowering of M_S and M_O criteria to adequately protect against "tsunami earthquakes" would result in an unacceptable number of false warnings (one or two per year).

We conclude that M_S and M_O criteria can provide efficient warnings for most earthquakes, but have the potential for rare but catastrophic failures. Therefore, it is important to recognize the limitations of warning systems based on M_S and M_O criteria, and to search for other parameters more closely related to tsunamis produced by earthquakes with relatively low values of M_S and M_O.

As a follow-up to the technical report, Dr. Dan Walker presented "A Review of Significant Tsunami Runups in Hawaii," a synthesis of runups published by Lander and Lockridge (1989) on Thursday, July 15, 1993, at the Joint Institute for Marine & Atmospheric Research (JIMAR) at the University of Hawaii-NOAA., for the major populated islands in Hawaii. His presentation discussed wrap-around effects, strange values, concerns with increased development and population, and implications for possible future measures of runups and numerical modeling efforts.

Aftershock Distribution of the May 17, 1992, Earthquake Near Manay, Davao Oriental.

By Narciso Diongson, Angelito G. Lanuza, Felix A. Marte, Ishmael C. Narag, Henremagne C. Penarubia

Abstract

The overall panic wrought by the M_S=7.3 Bislig Earthquake and its M_S=6.8 foreshock led the Philippine Institute of Volcanology and Seismology (PHIVOLCS) to dispatch an investigative team to monitor the ongoing aftershocks and to enhance public knowledge and awareness on possible hazards posed by earthquake generators of the Eastern Mindanao area. The team separated into two groups and were sent to conduct site investigation of the affected areas. The seismology group was tasked to record aftershocks within the area using 5 digital (EDR 1000) and one portable analog seismograph (Portacorder). Reliable software were used to process earthquake data.

Several issues were raised by the occurrence of the earthquake. Of major concern was how our present seismic network responded to the calamity and whether the main shock indicated a level of seismic hazard in excess of that previously believed to exist in the region.

Conclusions and Recommendations

The May 17, 1992, earthquake follows a foreshock main shock sequence and hereafter, an aftershock sequence. Aftershock observation confirms a shallow aftershock cluster.

The impact of the May 17, 1992, earthquake within the region

has raised the question of the adequacy of the existing seismic network in Mindanao.

This report hopes to present an important thrust towards the immediate construction of permanent seismic stations near the two earthquake generators of the Eastern Mindanao area namely the Philippine Fault Zone and the Philippine Trench. The continuing subduction activity of the Philippine Trench warrants the need for a tsunami hazard zonation of the eastern coast of Mindanao in order to pinpoint high risk areas which will serve as a guide for the Regional Planning Office in the preparation of its corresponding disaster preparedness program.

The 1992 Bislig Earthquake is a clear and ominous warning. Fortunately, it occurred in a sparsely populated region far from a major urban center which if it occurred within its confines, the consequences would have been greater. We encourage the municipal government to review its seismic safety programs in order to mitigate the damaging effects of a major earthquake. We also encourage the local government to post warning signs on buildings determined to bed hazardous in earthquakes and retrofit or vacate those buildings as soon as possible.

The authors wish to encourage research in the field of tsunami prediction and the adoption of counter-measures against these events such as the study of the configuration of shorelines and topography of land of tsunami prone areas. Special emphasis should be given to measures that would minimize the destructive force of a tsunami such as the building of breakwaters or simply the planting of tsunami control forests.

Houses should not be built below a standard level and roads leading to higher ground should be widened to facilitate evacuation measures. The authors also wish to encourage the construction on high ground of public buildings where people may assemble during these disasters. Actions taken will be reported at ITSU-XIV.

Post-Tsunami Survey (November 2-7, 1992) of Runup and Inundation in the Coast of Nicaragua. Tad S. Murty, Antonio M. Baptista, George R. Priest. Sponsored by the IOC

Abstract

The runup and inundation on the Pacific Coast of Nicaragua by the tsunami on September 1, 1992, was surveyed November 2 through 7. The survey team consisted of the three authors and a local interpreter. The measurements of runup were made with a survey staff and hand-held level, and the extent of inundation was determined through measurement with tape. The two months that had elapsed between the occurrence of the tsunamis and the survey allowed sufficient time for the near-coast vegetation to either become discolored or die.

This happened due to the fact that the vegetation, while it might be subjected to sea spray, cannot thrive on saltwater. It takes about six weeks' time for the saltwater to work through the root system and damage the vegetation, other than the physical damage directly attributable to the tsunami waves. In the survey, less emphasis was placed on the tsunami debris, since it was difficult to distinguish between tsunami debris and debris from normal high tide.

Also, some of the debris could have been displaced by other natural or man-made causes in the intervening two-month period. Some additional information was obtained from interviews with local witnesses of the tsunami event. These data will be used for the calibration and verification of at least two numerical models the authors are developing, one which is a finite difference model and other is a finite element model.

Runup and inundation measurements and estimates were made at several sites at each location. The tsunami runups were generally in the three- to five-meter range, but maximum amplitudes of up to 9.5 meters were noticed. The horizontal extent of inundation was typically on the order of a few hundred meters.

TSUNAMI WARNING CENTER REPORTS

Pacific Tsunami Warning Center (PTWC)

There have been a number of staffing changes and facilities projects at PTWC during the last six months. Charles "Chip" McCreery and Robert Cessaro joined PTWC as new, duty Geophysicists while Laura Kong transferred to the Hawaiian Volcano Observatory (on the island of Hawaii). In the main PTWC operations area, work continues on the restructuring of the office, rerouting of data lines and other cabling, and general realignment for improved operations and watch-stander work spaces. PTWC's lead electronics technician, Rich Nygard, and Al Lentz installed a tide gauge in Alofi, Niue, in late October. This project grew out of discussions between Gordon Burton (retired PTWC, GIC) and Jacques Talandier (retired, LDG-Tahiti) on ways to improve tsunami verification in the Tonga-Kermadec area of the Pacific.

Summary of Pacific Basin Earthquakes

with Surface Wave Magnitudes Greater than or Equal to 6.5
(From PTWC, January 1993 through November 1993)

Event	Date	Location	Time	Lat.	Long.	Ms	Action
93-01	Jan 13	South of Tasmania, Australia	1852Z	50.3S	141.4E	6.5	-
93-02	Jan 15	Hokkaido, Japan	1106Z	43.1N	143.8E	7.2	TIB*
93-03	Mar 6	Solomon Islands	0306Z	10.7S	164.3E	6.9	TIB
93-04	Mar 12	Fiji Islands	1402Z	13.3S	178.2E	6.5	TIB
93-05	Apr 19	Southern Philippine Trench	2102Z	04.5N	128.2E	6.7	TIB
93-06	May 11	Mindanao, Philippines	1827Z	07.4N	126.6E	6.6	TIB
93-07	May 13	Sand Point, Alaska	1200Z	55.5N	160.4W	6.9	-
93-08	May 15	Adak, Alaska	2152Z	51.2N	178.5W	6.7	-
93-09	May 16	Tonga Islands	2144Z	15.3S	173.0W	6.7	TIB
93-10	Jun 18	Kermadec Islands	1153Z	28.4S	177.2W	6.7	-
93-11	Jun 18	Kermadec Islands	1758Z	28.3S	177.1W	6.7	TIB
93-12	Jun 30	North Fiji Basin	2348Z	19.3S	172.9E	6.5	-
93-13	Jul 11	South of Antofagasta, Chile	1336Z	24.5S	70.2W	6.6	-
93-14	Jul 12	West of Hokkaido, Japan	1317Z	42.3N	139.4E	7.6	RWW*
93-15	Aug 8	Guam	0834Z	13.0N	144.8E	8.1	RWW
93-16	Aug 10	South Island, New Zealand	0052Z	45.2S	167.0E	7.1	TIB
93-17	Sep 5	New Ireland, Papua New Guinea	0356Z	03.4S	154.2E	6.5	-
93-18	Sep 10	Chiapas, Mexico	1913Z	14.6N	92.7W	7.2	TIB
93-19	Oct 13	Eastern New Guinea, PNG*	0206Z	05.9S	146.0E	7.2	TIB
93-20	Oct 13	Eastern New Guinea, PNG	0307Z	06.0S	146.2E	6.8	TIB
93-21	Oct 24	Guerrero, Mexico	0752Z	16.9N	98.6W	6.6	-
93-22	Oct 25	Eastern New Guinea, PNG	1027Z	05.9S	146.0E	7.1	TIB
93-23	Nov 13	SE Coast of Kamchatka, Russia	0133Z	52.3N	158.5E	6.8	-

**TIB - Tsunami Information Bulletin*
**RWW - Regional Watch/Warning*
**PNG - Papua New Guinea*

TSUNAMI WARNING CENTER REPORTS

PTWC Project of Updating the Tsunami Warning System Communications Plan

A major revision of the Tsunami Warning System Communications Plan is underway at the PTWC. PTWC will be corresponding directly with Comm Plan users, sending "change sheet" forms for updating. The communications data section of the publication is being produced from a single, computer database file. This database file contains a record for each Tsunami Warning System member. Each data record contains the following fields:

Agency Name:
Type agency:
acronym:
address line 1:
address line 2:
address line 3:
Street address:
City:
Country:
Primary 24 hr voice phone number:
Alternate voice phone number:
NOAA Weather Wire subscriber: (yes/no) [North America and Hawaii users]
FAX number:
TELEX number:
HCD subscriber: (yes/no) [Hawaii users]
AFTN address:
WMO header:
AUTODIN routing indicator:
AUTODIN Plain Language Address:
E-mail address:
Methods:
Latitude:
Longitude:
Date this record was last updated:

The first application of this database will be to produce the Communications Plan as a publication. However, at least two other applications are foreseen: (1) the TWS mailing lists for dissemination of the Communications Plan, ITIC Newsletters, and PTWC news items, and (2) a "lookup table" for new operational messaging software that will be developed at PTWC. The new publication will include more diagrams, maps, and other graphics which will show the flow of information to make the TWS communications scheme more understandable to everyone.

One goal for this "1990s" Comm Plan is to advertise to all the recipients not just the means by which users can communicate with the Tsunami Warning Centers, but also how they might communicate with each other. Major developments that have had impact on the TWS since the beginning of the decade have been the advent of facsimile, E-mail, and INTERNET.

Facsimile (fax) provides point-to-point transmission of either text or graphic products. Even though the PTWC is not presently configured to transmit fax products to everyone in the system during an event, this is a goal for the future; and graphics products are being developed with this in mind. For example, tsunami travel time charts can now be quickly generated for current earthquake events. However, faxing such a product to all TWS participants is not yet possible with current PTWC resources.

PTWC receives and sends E-mail by two different providers - OMNET and INTERNET.
The OMNET address is: tsunami.hawaii
The INTERNET E-mail address is:
ptwc@nalu.tsunami.soest.hawaii.edu

The warning center is beginning to conduct more of its day-to-day business using these E-mail addresses. INTERNET, however, is much more than an E-mail resource. It is literally a world-wide computer network. PTWC, for example, can now log onto computer systems at INTERNET-connected seismic centers anywhere in the world to gather seismic data or to conduct file transfers.

Alaska Tsunami Warning Center (ATWC)

Russian Tsunami Researchers Visit ATWC

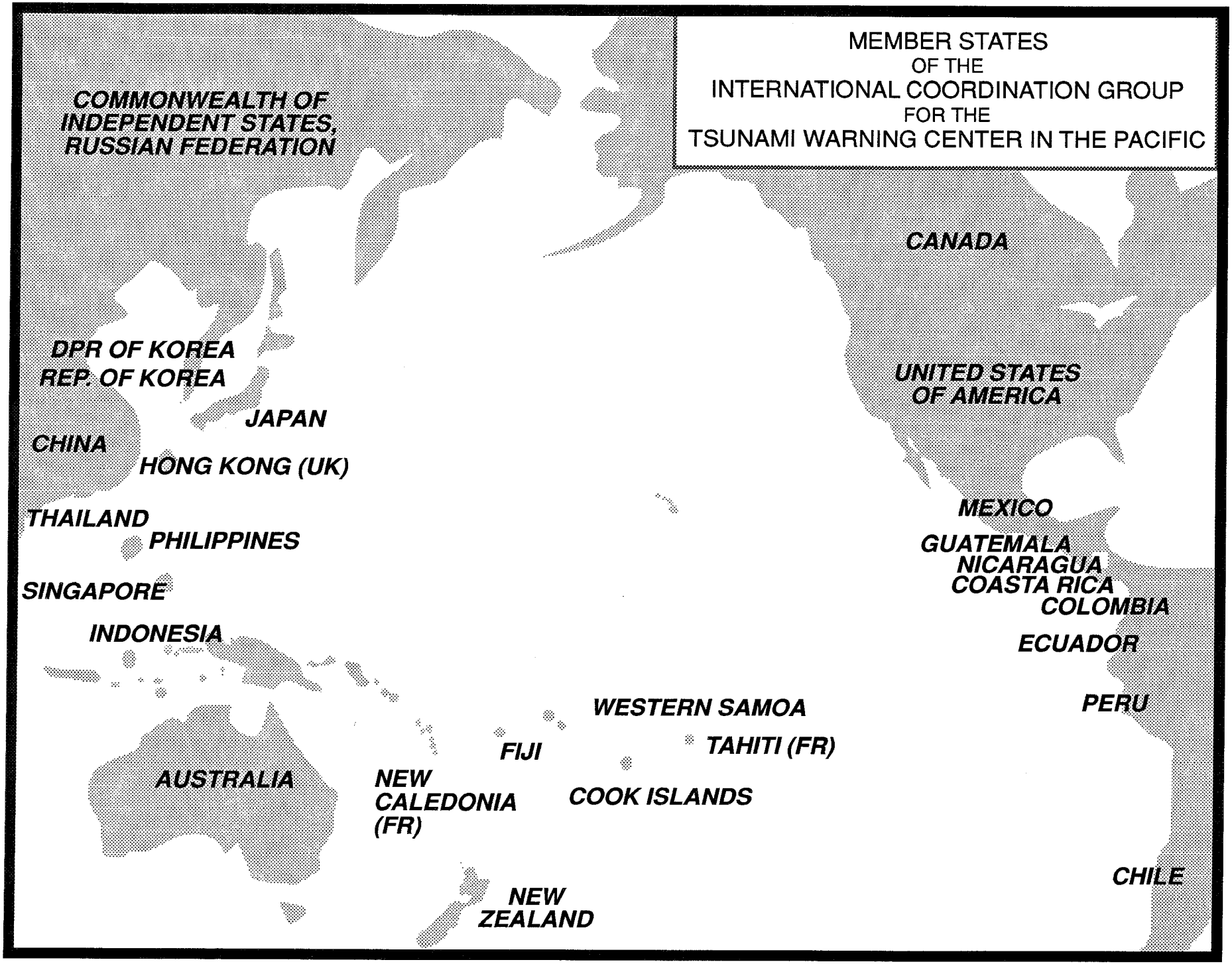
Drs. Viacheslav K. Gusiakov (Novosibirsk) and A. Kurbazov (Petropavlovsk) visited Thomas J. Sokolowski, Geophysicist in Charge of the ATWC, June 17-18, 1993. They were given an in-depth tour of the ATWC facilities and shown results of many ongoing projects. They were also showed some results of their software display applications, i.e., plots historical earthquakes and tsunamis impacting Kamchatka. Discussions included the ATWC's expert system, wave height determinations, the TWS, and ITSU.

HAPPY HOLIDAYS

AND THE BEST FOR THE

NEW YEAR!

FROM THE STAFF OF THE
INTERNATIONAL TSUNAMI INFORMATION CENTER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